



INTERNATIONAL CONFERENCE ON
**GREEN AND
SUSTAINABLE
DEVELOPMENT**



CONFERENCE PROCEEDINGS

8-12 MARCH
2026

PROTEA HOTEL STELLENBOSCH,
CAPE TOWN, SOUTH AFRICA

PROCEEDINGS EDITOR

Prof. Lerato E. Mdaka: North-West University, South Africa

This work represents the proceedings of the International Conference on Green and Sustainable Development, presented at the Protea Hotel Stellenbosch, Cape Town, South Africa from 8 to 12 March 2026.

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ISBN: 978-1-0370-6609-2 (e-book)

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MESSAGE FROM DESKTOP EDITOR AND CO-CHAIR



It is both an honour and a privilege to present this message as the Co-Chair and Desktop Editor of the 2026 International Conference on Green and Sustainable Development (ICGSD).

This conference has brought together a diverse and dynamic community of scholars, practitioners, and policymakers who share a common commitment to advancing sustainable development in its many dimensions. The breadth and depth of contributions captured in these proceedings reflect not only the complexity of the challenges we face but also the richness of ideas and solutions emerging from across disciplines and contexts.

In my role as Desktop Editor, I had the opportunity to coordinate the review of over 170 submissions. Each paper underwent a rigorous double-blind peer review process, supported by dedicated reviewers whose expertise and thoughtful engagement ensured the quality and integrity of this collection. I extend my sincere appreciation to all reviewers for their invaluable contributions, and to the authors for entrusting this conference with their work.

What stands out in these proceedings is the strong emphasis on interdisciplinary collaboration, innovation, and community engagement. Many of the contributions move beyond theoretical exploration to offer practical, contextually grounded solutions that speak directly to the pressing sustainability challenges of our time. This reflects a growing shift within higher education and research toward co-creating knowledge with communities and stakeholders, ensuring that our work is both relevant and impactful.

As we reflect on the insights presented in this volume, it is clear that sustainable development requires not only academic excellence but also collective action, ethical leadership, and sustained partnerships. Conferences such as ICGSD serve as important platforms for fostering these connections and for advancing dialogue that can inform policy, practice, and future research.

I hope that the ideas contained in these proceedings will inspire continued collaboration and innovation, and that they will contribute meaningfully to efforts aimed at building more sustainable, inclusive, and resilient societies.

On behalf of the organising committee, I thank all participants for their contributions and engagement. It has been a privilege to be part of this important scholarly endeavour.

Prof Juliet Townes

Desktop Editor

University of Fort Hare, South Africa



CONFERENCE REVIEW PROCESS

North-West University Business School in collaboration with the University of Kigali, University of Fort Hare, and Tshwane University of Technology hosted the International Conference on Green and Sustainable Development 2025 held at Protea Hotel Stellenbosch, South Africa from 8 – 12 March 2026. The call for papers and review process was as follows:

The call for Competitive Papers, Work-in-Progress (WIP) submissions, PhD Colloquium submissions, and Innovation Showcase submissions opened on 1 September 2025. The initial submission closing date for all submissions was 31 October 2025. Due to requests from prospective participants, the submission deadlines were revised, with WIP Abstract submissions closing on 10 November 2025, while Competitive Papers, PhD Colloquium Papers, and Innovation Showcase submissions closed on 5 January 2026.

A total of 171 submissions were received, comprising 78 Full Paper submissions, 73 Work-in-Progress submissions, 15 PhD Colloquium submissions, and 5 Innovation Showcase submissions. All submitted papers underwent a double-blind peer review process. The identities of the authors were not disclosed to the reviewers to ensure an objective and impartial evaluation process.

All reviewers were assigned, distributed, and recorded by the Desktop Editor. Reviewers were allocated papers according to their priority topic areas and expertise. Assigned review papers were communicated electronically via Microsoft Outlook.

Reviewers were requested to evaluate full paper submissions according to the following weighted criteria:

1. Title, Abstract and Keywords (5%)
2. Introduction (10%)
3. Literature Review and Problem Investigated (15%)
4. Research Objectives and Hypotheses (5%)
5. Methodology (15%)
6. Results, Findings and Conclusions (20%)
7. Contribution of the Study (20%)
8. Technical Care (10%)

Authors received reviewer feedback and were required to submit revised final papers. Acceptance notifications were communicated on a rolling basis.

The initial final corrected paper submission deadline was 30 November 2025 and was later revised to 20 January 2026. Registration for the conference opened on 30 November 2025, with Early Bird Registration closing on 15 December 2025 and final registration closing on 28 February 2026.



CONFERENCE REVIEW PROCESS

Following the review process, accepted papers were scheduled for presentation during the conference programmes held from 9–11 March 2026 in Stellenbosch, South Africa.

A total of 171 submissions were received for the conference, comprising 73 Work-in-Progress submissions, 78 Full Paper submissions, 15 PhD Colloquium submissions, and 5 Innovation Showcase submissions. Following the double-blind review process, a total of 157 submissions were accepted for inclusion in the conference programme.

For the Full Paper track, of the 78 submissions, 67 were accepted with 11 rejections and withdrawals combined. 52 papers were included into the conference programme. Following the presentation process and final editorial review, 28 papers were included in the official conference proceedings, while 10 high-quality papers were selected for publication in partner journals.

A total of 29 accepted full papers were excluded from the proceedings due to non-attendance, primarily linked to funding and travel constraints.

The PhD Colloquium and Innovation Showcase tracks achieved full participation, with all accepted submissions presented during the conference programme.

Prof. Joseph Lekunze

Conference Chair

NWU Business School, South Africa

Prof. Juliet Townes

Desktop Editor

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Desktop Deputy Editor

North-West University, South Africa



LIST OF AUTHORS OF FULL PAPERS

A total of 54 unique authors from 14 higher education institutions and academic organisations across South Africa, Rwanda, Kenya, Nigeria, and Brazil are represented. The author cohort reflects a diverse and collaborative network of scholars, researchers, and practitioners, originating from institutions other than North-West University, demonstrating the conference's broad national and international reach and its commitment to fostering inter-institutional research collaboration.

The following list presents the authors who contributed to the conference proceedings, together with their institutional affiliations.

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CONTRIBUTIONS PER INSTITUTION

North-West University contributed 36.36% of the authors represented in the proceedings, while 63.64% of the authors were affiliated with other institutions, indicating substantial institutional diversity and collaboration across South Africa and internationally. The DHET 60% threshold was therefore met.

Institution	Country	Contributors	Percentage (%)
North-West University	South Africa	20	36.36%
University of Fort Hare	South Africa	8	14.55%
Tshwane University of Technology	South Africa	6	10.91%
University of Kigali	Rwanda	5	9.09%
KCA University	Kenya	3	5.45%
University of Johannesburg	South Africa	2	3.64%
University of São Paulo	Brazil	2	3.64%
University of the Western Cape	South Africa	2	3.64%
African Leadership University	Rwanda	1	1.82%
Boston City Campus	South Africa	1	1.82%
Monarch University	Nigeria	1	1.82%
STADIO Higher Education	South Africa	1	1.82%
University of South Africa	South Africa	1	1.82%
Walter Sisulu University	South Africa	1	1.82%
Total	5 Countries	54	100.00%

CONFERENCE THEMES

- Theme 1: Climate Change Mitigation and Adaptation Systems
- Theme 2: Sustainable Business, Management, and Economics
- Theme 3: Social Equity and Sustainable Development
- Theme 4: Sustainable Agriculture and Food Systems
- Theme 5: Environmental Policy and Governance
- Theme 6: Green Technologies and Innovation

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Commercialisation of Indigenous Knowledge-Based Innovations for Sustainable Development: A South African Perspective



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People-Centered Leadership and Stakeholder Synergy: A Human Capital Pathway for Sustainable Development



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Democratising Sustainable Development: Women, Leadership and Inclusive Growth in the 21st Century



PROF ALFONSO DURÁN-HERAS

Professor and Director, Universidad Carlos III de Madrid (UC3M)

Current Supply Chain challenges; sustainable capacity building and upskilling



DR SIMON PETER NADEEM

Senior Programme Manager, Learn Logistics by Kuhne Foundation

Circular Economy, Lean Practices and Resilient Supply Chains for Sustainable Development
Current Trends and Future Opportunities



PROF LUCIUS BOTES

Professor of Development Studies and Director Research Development at North-West University, South Africa.

Sustainable livelihoods for human development



PANEL DISCUSSIONS

Conference Co-Chairs' Address: Role of Higher Learning Institutions in Fostering Sustainable Development

Moderated by Prof Lerato E Mdaka

- Dr Ronald Kwenza: University of Kigali, Rwanda
- Prof Juliet Townes: University of Fort Hare, South Africa
- Prof Joseph Lekunze: North-West University Business School, South Africa
- Dr Sindi X. Mokgopha: Tshwane University of Technology, South Africa

Driving Green Innovation and Sustainable Business Growth: Policies, Technologies, and Global Partnerships

Moderated by Dr Alexander Samuels

- Prof Mulatu Fekadu Zerihun: Professor, Tshwane University of Technology, South Africa
- Prof Janet Bagorogoza: Professor, Makerere University Business School, Uganda
- Prof Nelda Mouton: Associate Professor, NWU Business School
- Prof Richard Shambare: Dean of the Faculty of Management and Commerce, University of Fort Hare, South Africa
- Dr Ntsele Khumalo: Senior Lecturer, NWU Business School, South Africa

Panel Discussion: Indigenous Knowledge-Based Health Innovation: From Traditional Medicine for Humans to Ethno-Veterinary Medicine

Moderated by Dr Vuyisile Hobololo

- Dr Nqobile Masondo: Senior Researcher, Agricultural Research Council – Vegetables, Industrial and Medicinal Plants Institute, South Africa
- Ms Philasande Mahlakatha: Director, Abalimi Bomya Association, South Africa
- Prof Nceba Gqaleni: Research Professor, Traditional Medicine, University of KwaZulu-Natal, South Africa
- Prof Lyndy McGaw: Phytomedicine Professor, Department of Paraclinical Sciences, Faculty of Veterinary Sciences, University of Pretoria, South Africa
- Prof Prince Wasajja Kiwanuka: National Chair, Traditional and Native Knowledge Committee, Ministry of Gender, Labour and Social Development, Uganda.



PHD COLLOQUIUM

The PhD Hub for Africa, a flagship strategic initiative of the NWU Business School, in collaboration with the University of Fort Hare hosted the PhD Colloquium. The platform provided doctoral candidates with the opportunity to present their research, receive expert feedback and engage in meaningful scholarly dialogue. The colloquium aimed to amplify African-led research on sustainability and foster a strong network of emerging African scholars across the continent and the African diaspora.

Objectives

The 1-day full colloquium provided PhD candidates with the opportunity to:

- Present and share their research-in-progress
- Receive constructive feedback from academics and experts
- Engage with peers, supervisors, and mentors from across Africa
- Strengthen their academic and research profiles
- Explore interdisciplinary perspectives on sustainability and development

Eligibility

The colloquium is open to registered PhD students from any discipline aligned with sustainability, innovation, entrepreneurship, business, management, economics, social development, environmental studies, and related fields across Africa and the African diaspora.

PhD Colloquium Participants

1. **Mr Amanze Edwin – NWU Business School, South Africa**
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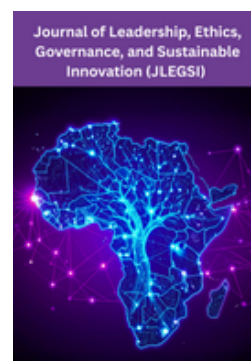


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Towards a Human-Centric and Sustainable Future: AI- Driven Predictive Analytics, Statistical Trends, and Supply Chain Management from Industry 4.0 to 5.0

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Abstract

Background: This study examines the integration of Artificial Intelligence (AI) in supply chain management (SCM) during the transition from Industry 4.0 to Industry 6.0. The focus is on improving operational efficiency, fostering human-centric collaboration, and promoting sustainability across supply chains. As industries evolve, the integration of AI to improve decision-making and strengthen operational resilience, while upholding sustainable practices, becomes increasingly vital.

Methods: Following the PRISMA framework, a systematic review was conducted to collect and analyse relevant literature published between 2010 and 2023. A thorough search was performed across multiple databases, including Web of Science, Scopus, IEEE Xplore, Google Scholar, and ScienceDirect. The review involved rigorous eligibility screening and thematic analysis using Atlas-ti software to extract key themes and trends related to AI integration in SCM.

Results: The review reveals that AI integration markedly improves SCM by improving demand forecasting, inventory management, and overall decision-making capabilities. As industries shift towards Industry 5.0, a greater emphasis on human-AI collaboration emerges, fostering enhanced customisation and innovative problem-solving. However, AI technologies contribute to sustainability by optimising resource utilisation and minimising environmental impacts. Nonetheless, challenges such as cybersecurity vulnerabilities and gaps in workforce skills must be addressed to fully harness AI's potential.

Conclusion: The integration of AI in SCM not only drives operational efficiency and sustainability but also strengthens resilience against disruptions. The insights from this systematic review provide valuable guidance for both academics and practitioners seeking to optimise supply chain operations through AI across the transition from Industry 4.0 to Industry 6.0. The study emphasizes the need for a balanced approach that combines technological advancements with human-centric and sustainable practices.

Keywords: AI-driven predictive analytics, human-centric technologies, Industry 4.0, Industry 5.0, sustainable supply chain management.

JEL Classification: C53, O33, Q01



1. Introduction

The integration of advanced technologies and a human-centric approach is emphasised in the transition from Industry 4.0 to Industry 5.0, which represents a significant evolution in manufacturing and supply chain management. Industry 4.0 is defined by the digital transformation of production systems via cyber-physical systems, the Internet of Things (IoT), and data analytics, enabling real-time decision-making and operational efficiency Csalódi *et al.* (2021). This period has allowed organisations to attain improved agility and responsiveness in their supply chains, crucial for managing the complexities of contemporary markets (Chen, 2019). Agility of supply chains is key as companies encounter escalating uncertainties and competitive pressures, requiring transition adaptation to fluctuations in demand and supply conditions (Chen, 2019; Ye, 2023). The emphasis is transitioning towards a more sustainable and human-centric model that integrates advanced technologies with human intelligence as we progress towards Industry 5.0. This transition is motivated by the acknowledgement that although automation and data analytics improve operational efficiency, the human component is key for creativity, innovation, and ethical decision-making (Purwandaru, 2023). In this context, supply chain management is advancing to integrate sustainability as a fundamental principle, in accordance with the overarching objectives of economic, environmental, and social sustainability (Sadurdeen, 2019; Purwandaru, 2023). The integration of green supply chain management practices is increasingly regarded as a competitive advantage, leading organisations to implement strategies that reduce environmental impact while improving resource efficiency (Kazançoğlu *et al.*, 2018).

Additionally, the position of AI and predictive analytics in supply chain management is becoming increasingly prominent. These technologies allow organisations to predict demand, optimise inventory levels, and improve overall supply chain visibility (Boye, 2021). AI-driven predictive analytics enables companies to foresee disruptions and respond proactively, thus improving resilience in their supply chains (Lücker & Seifert, 2017). This capability is crucial given the recent global supply chain disruptions, highlighting the necessity for effective risk management strategies (Ye, 2023).

Machine learning (ML) and other AI technologies have improved an organization's capacity to predict demand, optimise inventory, and increase the resilience of the supply chain. This transformation is crucial as enterprises seek efficiency and sustainability in their operations. Artificial intelligence-driven predictive analytics enables more precise demand forecasting by analysing extensive historical data and identifying patterns those human analysts may overlook. This ability is key in alleviating the bullwhip effect, wherein minor demand fluctuations can result in significant discrepancies in supply chain operations. Research indicates that AI and ML applications can significantly mitigate this effect, resulting in improved production decisions and inventory management (Belhadi *et al.*, 2021b). However, AI's predictive abilities allow organisations to foresee market fluctuations and adjust their strategies, accordingly, thus improving operational performance (Singh, 2023).

The role of AI in predictive analytics is not limited to forecasting; it also includes the management of risk within supply chains. Organisations can utilise AI to detect potential risks, including fraud and human error, that may disrupt supply chain operations. Studies demonstrate that the utilisation of AI and ML can markedly improve supply chain efficiency and mitigate associated risks (Lokanan & Maddhesia, 2022). Furthermore, AI's capacity to analyse real-time data enables companies to promptly address disruptions, thereby improving supply chain resilience, a crucial element



emphasised during the COVID-19 pandemic (Modgil *et al.*, 2021a). AI's influence on supply chain management also includes sustainability as a key component. AI technologies improve the establishment of more sustainable practices by optimising resource utilisation and reducing waste. AI can improve environmental management strategies by incorporating sustainability metrics into supply chain decision-making processes (Sanders *et al.*, 2019; Wang, 2022).

The objectives of this study is to analyse the impact of AI-driven predictive analytics on supply chain optimization and sustainability, focusing on key performance metrics from Industry 4.0 to Industry 5.0, to explore the role of human-centric technologies in improving supply chain resilience and adaptability in the transition from Industry 4.0 to Industry 5.0 and to assess the statistical trends in supply chain management that highlight the integration of AI and sustainable practices, contributing to a more efficient and environmentally conscious future.

2. Literature Review

Evolution from Industry 4.0 to Industry 5.0

The integration of cyber-physical systems, the Internet of Things (IoT), and big data analytics, known as Industry 4.0, has fundamentally transformed supply chains by improving operational efficiency and facilitating real-time data-driven decision-making (Mourtzis *et al.*, 2022). As progressions towards Industry 5.0, there is an increasing acknowledgement of the necessity to integrate human factors and sustainability into supply chain practices, thus improving resilience and adaptability in a more complex global environment. Adopting advanced technologies is one of the critical components of this evolution, as it improves the resilience of the supply chain. Technologies associated with Industry 4.0, including artificial intelligence (AI) and blockchain, have significantly improved supply chain performance by improving risk management and enabling more agile responses to disruptions (Ivanov *et al.*, 2021). AI-driven predictive analytics can improve inventory management and demand forecasting, enabling companies to respond more efficiently to variations in supply and demand (Marinagi *et al.*, 2023).

However, the integration of blockchain technology improves transparency and traceability in supply chains, which is key for encouraging trust among stakeholders and ensuring adherence to sustainability standards (Yerpude *et al.*, 2022). The focal point is transition ing towards a more human-centric approach that prioritises collaboration between humans and machines as we transition to Industry 5.0. This paradigm acknowledges that although technology is key for improving supply chain efficiency, human judgement and creativity are equally vital in addressing complex challenges (Nyamekye, 2023). Research indicates that cultivating a culture of collaboration and ongoing learning within organisations can markedly improve supply chain resilience (Wieland & Durach, 2021). Companies that emphasise employee training and development in digital skills are more adept at utilising technological advancements and adjusting to evolving market conditions (Um & Han, 2020). Additionally, the integration of sustainability into supply chain practices is becoming more critical in the context of Industry 5.0. The focus on sustainable practices mitigates environmental issues while simultaneously strengthening supply chain resilience by decreasing reliance on limited resources and minimising waste (Hsu, 2021). Studies demonstrate that organisations implementing sustainable supply chain strategies are more inclined to attain enduring success and sustain competitive advantages amid disruptions (Novak *et al.*, 2021). The adoption of circular economy principles in



supply chains can improve resource efficiency and diminish environmental impact, thus advancing sustainability objectives (Mourtzis *et al.*, 2022).

AI-Driven Predictive Analytics

The capacity of AI-driven predictive analytics to improve supply chain resilience is one of its main advantages. Liu *et al.* (2023) emphasise that the implementation of advanced decision-making technologies markedly improves supply chain resilience by mitigating risks and improving decision quality. This is especially pertinent following disruptions like the COVID-19 pandemic, which tested conventional supply chain models. Özdemir *et al.* (2022) asserts that resilience strategies, such as redundancy and capacity improvement, not only alleviate immediate disruptions but also bolster long-term supply chain sustainability. The research by Iftikhar *et al.* highlights the significance of big data analytics in addressing supply chain complexities, indicating that cultural factors contribute to resilience management (Iftikhar *et al.*, 2022).

It is impossible to overstate the significance of human-centric technologies in supply chain management. Nikookar and Yanadori (2021) contend that human capital is key for addressing supply chain disruptions, proposing that an emphasis on human-centric strategies can improve resilience. This corresponds with the conclusions of Wieland *et al.* (2021), who promote a sophisticated comprehension of supply chain dynamics that integrates ecological considerations and the inherent unpredictability of supply chain interactions. The integration of AI and big data analytics improves this human-centric methodology by delivering real-time insights that enable decision-makers to react adeptly to evolving circumstances.

Furthermore, the transition from Industry 4.0 to Industry 5.0 highlights how important it is for supply chains to adopt sustainable practices. Research suggests that AI-driven predictive analytics can significantly aid in achieving sustainability objectives. Zhu *et al.* (2018) illustrate how supply chain analytics improves transparency, key for mitigating sustainability risks linked to unethical practices. The authors suggest emphasise the significance of data-driven analysis in addressing supply chain vulnerabilities, proposing that a proactive sustainability strategy can alleviate risks linked to disruptions (Bui *et al.*, 2021). The Walmart case, as highlighted by Zhan and Tan, illustrates how big data analytics can improve operational efficiency and sustainability via informed decision-making (Zhan & Tan, 2020).

Sustainability in Supply Chain Management

To optimise supply chains and advance sustainable practices, this transition emphasises the integration of predictive analytics and artificial intelligence (AI). The literature indicates that AI-driven technologies can significantly improve the efficiency and sustainability of supply chains by enabling superior decision-making, optimising resource allocation, and promoting collaboration among supply chain partners. Artificial intelligence's contribution to sustainable supply chain management is multifaceted. It allows companies to assess extensive data, resulting in more informed choices concerning supplier selection and evaluation based on environmental and social performance indicators. Busse *et al.* emphasise the significance of sustainable supplier evaluation processes, which can be augmented through AI analytics, enabling firms to establish collaborative development objectives that improve sustainability performance throughout the supply chain (Busse *et al.*, 2016).



Abbasi et al. emphasise the importance of environmental collaboration in supply chains, proposing that AI can improve communication and cooperation among stakeholders, thus augmenting sustainable performance (Abbasi *et al.*, 2016). Additionally, the transition to sustainable practices is frequently facilitated by the implementation of cutting-edge technologies, including blockchain and digital business transformation. Belhadi et al. examine the mediation of organisational ambidexterity and digital transformation in the relationship between Industry 4.0 capabilities and sustainable supply chain performance, proposing that these technologies enable firms to adapt to evolving market demands while upholding sustainability objectives (Belhadi *et al.*, 2021a). This corresponds with Wang's findings, which demonstrate that AI can improve supply chains by promoting environmental management practices that are consistent with sustainable development goals (Wang, 2022).

Supply chain resilience and adaptability are also addressed by the integration of AI, particularly in the context of disruptions like the COVID-19 pandemic. Aunyawong et al. assert that proficient management practices, augmented by AI, can elevate the sustainability performance of logistics service providers through the optimisation of resource allocation and improvement of operational efficiency (Aunyawong *et al.*, 2021). This is vital as companies endeavour to sustain competitive advantages while complying with sustainability mandates, as emphasised by Vafaei et al., who contend that sustainable supply chain management is imperative for attaining enduring competitive advantages via innovation and process management (Vafaei *et al.*, 2019).

Statistical Trends in Supply Chain Management

The visibility and decision-making capabilities of the supply chain are significantly improved by AI technologies, particularly machine learning (ML) and big data analytics. These technologies allow companies to analyse extensive data sets, resulting in improved demand forecasting and inventory management, which are key performance metrics in supply chain management (Singh, 2023). Predictive analytics can markedly decrease lead times and improve responsiveness to market fluctuations, thus augmenting overall supply chain efficiency (Verma, 2018). The capacity to analyse real-time data enables organisations to make prompt, informed decisions, which is crucial in the contemporary rapid business landscape (Dey et al., 2023). Furthermore, the significance of AI in improving supply chain resilience is paramount. Research indicates that AI-driven decision support systems improve agility and resilience in supply chains, allowing companies to respond effectively to disruptions (Dey *et al.*, 2023).

During the COVID-19 pandemic, organisations that utilised AI for resource orchestration and real-time monitoring were more effectively equipped to handle supply chain disruptions (Queiroz *et al.*, 2022). This adaptability is key for ensuring operational continuity and encouraging sustainable practices, as resilient supply chains are more capable of addressing unforeseen challenges while reducing environmental impacts (Sanders *et al.*, 2019). Artificial intelligence (AI) integration also facilitates the transition to more sustainable supply chains. AI technologies improve the sustainability of supply chain processes by optimising resource allocation and minimising waste (Sanders *et al.*, 2019). AI can assist in the selection of suppliers according to their sustainability practices, thus encouraging environmentally responsible operations (Zhu & Wu, 2022). However, the application of AI in predictive maintenance and process optimisation not only improves operational efficiency but also diminishes the carbon footprint linked to supply chain operations (Verma, 2018).

Challenges and Gaps in the Literature



The necessity of a human-centric approach that prioritises sustainability becomes more urgent as industries transition from Industry 4.0 to Industry 5.0. This discourse integrates diverse academic contributions to describe these challenges and suggest avenues for additional inquiry. The absence of comprehensive frameworks that effectively integrate AI with sustainability principles is a significant gap in the literature. Haidar (2023) underlines the imperative for organisations to comprehend AI principles, especially regarding sustainability. This awareness is key as digital transformation presents strategic challenges that necessitate a sophisticated comprehension of AI's impact on sustainable practices. Naeeni (2023b) advocates for a comprehensive approach to sustainable AI that includes environmental, social, and economic aspects. Nevertheless, the literature remains deficient in comprehensive frameworks that can assist organisations in integrating AI in accordance with sustainable development goals (SDGs). Additionally, little is known about the ethical issues surrounding the use of AI in sustainable strategies. Jobin and Ienca (2019) emphasise the risk of reduced oversight when public confidence in AI takes precedence over ethical governance. This prompts apprehensions regarding the ethical implications of AI implementations across diverse sectors, including supply chain management. Daramola (2023) highlights the ethical dilemmas encountered in the integration of AI within SDG initiatives, including transparency and data privacy concerns. These ethical dilemmas require additional research to establish guidelines that guarantee the responsible and sustainable deployment of AI technologies. The intersection of AI and specific sectors, such as agriculture and healthcare, is another critical area that requires further investigation. AI has the potential to facilitate significant sustainability outcomes. Ibrahim (2023) examines the transformative impact of AI on agricultural extension services, while acknowledging the deficiencies in comprehending its complete potential for sustainable development.

Theoretical framework for this study

The Resource-Based View (RBV) and the Socio-Technical Systems (STS) theory are the central theories that support this research. The strategic significance of utilising an organization's distinctive resources and capabilities, such as AI-driven predictive analytics and advanced technological infrastructures, to achieve a competitive advantage is emphasised by the RBV. In the context of this research, AI technologies are positioned as critical resources that improve the resilience and efficiency of the supply chain by facilitating real-time decision-making and operating at optimal efficiency. This is further supported by the STS theory, which offers a framework for the integration of human-centric technologies into the socio-technical environment of Industry 5.0. It emphasises how technological development and human creativity are interdependent, and how this relationship promotes supply chain management innovation and sustainability. Collectively, these theories establish the groundwork for comprehending the collaborative resolution of modern supply chain challenges through AI-driven technologies and human-centric approaches.

3. Methodology

PRISMA Methodology

The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework offers a structured and dependable methodology for the conduct of systematic reviews and meta-analyses, thereby guaranteeing the comprehensiveness, precision, and transparency of research synthesis. During the transition from Industry 4.0 to Industry 5.0, this methodology is especially pertinent for the analysis of the integration of AI-driven predictive analytics, human-centric



technologies, and statistical trends in supply chain management. The review's objective is to conduct a systematic assessment of the current body of knowledge regarding the role of AI and sustainable practices in improving the performance of supply chains and increasing their adaptability and resilience, in accordance with the objectives of this study.

Inclusion and Exclusion criteria

The purpose of this investigation is to evaluate the influence of AI-driven predictive analytics on sustainability and supply chain optimisation, with a particular emphasis on critical performance metrics from Industry 4.0 to Industry 5.0. Statistical trends that emphasise the integration of AI and sustainable practices for a more efficient, environmentally conscious future are assessed, and the role of human-centric technologies in improving supply chain resilience and adaptability during this transition is examined. An approach to systematic review was implemented to guarantee the inclusion of pertinent, high-quality literature to accomplish these objectives. The selection criteria were explicitly defined.

From 2010 onwards, the inclusion criteria prioritise studies that investigate the integration of AI in supply chain management, including areas such as demand forecasting, inventory control, transportation, and supplier management, and that concentrate on Industry 4.0, Industry 5.0, or Industry 6.0. Environmental and social impacts are also taken into account in research that addresses the implications of AI for sustainability. The exclusion criteria exclude studies that are not relevant to these frameworks, non-industrial contexts, publications prior to 2010, non-scholarly sources, and papers in languages other than English. A thorough synthesis of current, methodologically sound research is ensured by this systematic review, which offers insightful information about the revolutionary role that artificial intelligence (AI) and human-centric technologies play in developing resilient and sustainable supply chains.

Search strategy

The objective of this investigation is to evaluate the influence of AI-driven predictive analytics on sustainability and supply chain optimisation, with a particular emphasis on critical performance metrics from Industry 4.0 to Industry 5.0. It examines the role of human-centric technologies in improving the resilience and adaptability of the supply chain during this transition and evaluates statistical trends that blend AI and sustainable practices to promote environmental consciousness and efficiency. A systematic literature review methodology was implemented to guarantee a structured and comprehensive approach to achieving these objectives.

A meticulous search strategy was implemented to identify pertinent studies from scholarly databases, such as Scopus, Web of Science, IEEE Xplore, Google Scholar, and ScienceDirect. The selection of these databases was based on their extensive collection of peer-reviewed journals, conference proceedings, and industry reports in the fields of industrial engineering, artificial intelligence, and supply chain management. Keywords including "Industry 4.0," "Industry 5.0," "Industry 6.0," "artificial intelligence," "AI," "supply chain management," and "digital transformation" were discerned and refined via initial searches and expert consultations. The search's precision was improved by the application of Boolean operators (AND, OR, NOT), such as "Industry 4.0 AND artificial intelligence" and "Industry 5.0 AND supply chain management". This meticulous search strategy guaranteed the



inclusion of a diverse and high-quality source of information, thereby establishing a strong foundation for the systematic review.

In order to improve the search, the following search string was utilised: (“AI-driven predictive analytics” OR “artificial intelligence” OR “AI technologies” OR “machine learning”) AND (“supply chain management” OR “SCM” OR “supply chain optimization”) AND (“sustainability” OR “sustainable practices” OR “environmental sustainability”) AND (“Industry 4.0” OR “fourth industrial revolution”) AND (“Industry 5.0” OR “fifth industrial revolution” OR “human-centric technologies”) AND (“resilience” OR “supply chain resilience” OR “adaptability”) AND (“statistical trends” OR “data analytics” OR “predictive analytics”) AND (“2010-2023” OR “recent studies” OR “systematic review”). This study examines AI-driven predictive analytics for optimising supply chains and improving sustainability, highlighting key performance metrics and human-centric technologies from Industry 4.0 to 5.0. An analysis of statistical trends from 2010 to 2023 emphasises the incorporation of AI and sustainable practices, utilising recent developments to maintain relevance in modern supply chain management research.

Data extraction and synthesis method

The emphasis of this study is on the transition from Industry 4.0 to Industry 5.0, with a particular focus on the impact of AI-driven predictive analytics on supply chain optimisation and sustainability. A comprehensive review of the literature utilising the PRISMA framework identified 33 publications from 2020 to 2023. The researcher focused on publications from 2010 to 2023 there was a lack of research on the focal area of this study, hence the timeframe of 2020 to 2023 had to be included, due to noteworthy research being done, concentrating on AI integration, supply chain management, and the transition to human-centric and sustainable practices. The investigation examines into the role of human-centric technologies in improving adaptability and resilience, as well as the major performance metrics, benefits, and challenges associated with AI integration. The research offers strategic recommendations for utilising AI to develop sustainable and efficient supply chain systems by synthesising these insights. The meticulous review of 33 selected articles was conducted to extract data, which included the capture of critical details such as the types of AI technologies employed, notable findings, and their implications on supply chain resilience and adaptability. The data extraction form was standardised to guarantee comprehensiveness and consistency, with an emphasis on the strategic insights for sustainable integration and the advantages and limitations of AI adoption. A thematic analysis approach was implemented to synthesise the data. This approach identified recurring patterns and key concepts, thereby organising the results into themes such as technological developments, integration benefits, encountered challenges, and strategic recommendations. Through human-centric methodologies, the themes emphasised the transformative impact of AI-driven predictive analytics in the optimisation of supply chain operations, the improvement of sustainability, and the cultivation of resilience. By synthesising these insights, the research offers a cohesive account of the capacity of AI technologies to improve supply chain practices, aligning operational objectives with overarching environmental and societal aims for a sustainable future.

Quality assessment of the selected studies

The PRISMA framework was employed to conduct a rigorous quality assessment of selected studies in order to guarantee the precision and dependability of the results. Studies were meticulously selected for their relevance to Industry 4.0 and Industry 6.0 themes, specifically regarding sustainable



supply chain management. Quantitative studies were evaluated for statistical analyses, sample sizes, and control methods, while qualitative research was evaluated for theoretical coherence and depth of analysis. Methodological rigour was emphasised in the evaluation. Mixed-methods studies were assessed for their capacity to integrate data comprehensively. The reporting quality was assessed in addition to the methodological assessment to guarantee the clarity and comprehensiveness of the documentation of research processes, findings, and limitations. Research presenting explicit methodologies and significant discourse gathered elevated ratings. Finally, the critical evaluation of each study's contribution to the advancement of knowledge in AI, human-centric technologies, and sustainable supply chains was conducted. Rigorous studies contested traditional paradigms, presented novel insights, or thoroughly synthesised existing literature, thereby providing significant direction for future research and practical applications in sustainable and human-centric supply chain management.

4. Results

The study's objective is to examine the influence of AI-driven predictive analytics on supply chain optimisation and sustainability, with a particular emphasis on critical performance metrics that are important during this transition. Statistical trends that emphasise the integration of AI with sustainable practices for a more efficient and environmentally conscious future are assessed, while the role of human-centric technologies in improving supply chain resilience and adaptability is further investigated. The study employs the PRISMA flow diagram to guarantee a rigorous and transparent methodology, employing a systematic literature review approach. This encompasses comprehensive reporting on the records that have been identified, screened, and selected, resulting in reliable, high-quality insights. The research provides valuable perspectives on the developments of SCM through AI-driven innovation and human-centric strategies by systematically synthesising relevant studies.

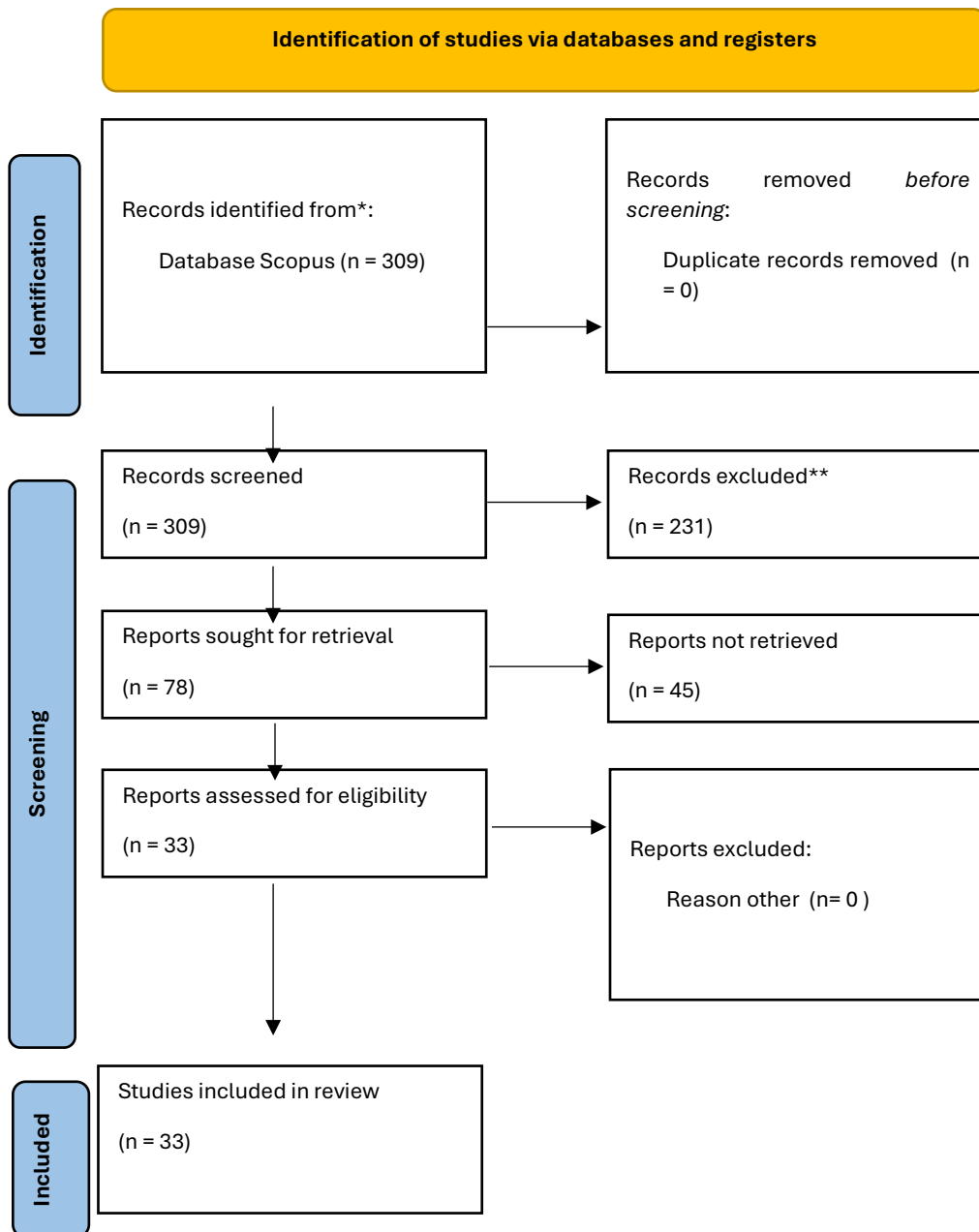


Figure 1: PRISMA flow diagram

Source: Rethlefsen *et al.* (2021)

The bar graph below Figure 2 labelled “Country/Territory” provides a visual representation of academic contributions from a variety of countries. The y-axis represents the quantity of documents produced, while the x-axis refers to the names of countries or territories. The graph clearly indicates that India has made the most significant contribution, producing 11 documents. This emphasizes the country’s dominant role in the research field during the studied timeframe. United Kingdom ranks next with a total of 9, indicating notable yet relatively diminished academic engagement. France and



Malaysia have produced a research output of 4 each, whilst Italy and China have 3 each respectively. However, numerous nations, including have provided minimal outputs, as evidenced by one or two documents. The distribution implies that there are disparities in research focus and capability, which could be explained by variations in funding, institutional priorities, or technological infrastructure. The concentration of expertise or policy support in advancing research could be indicated by the dominance of certain countries. A more in-depth analysis of the documents' origins may reveal collaborative patterns, regional priorities, or thematic concentrations.

The apparent discrepancies in academic output among countries indicate an uneven adoption and exploration of technologies that are critical to the transitions to Industry 4.0 and 5.0. Countries with the highest document contributions likely serve as centres of innovation where AI and human-centric technologies are actively integrated into supply chain practices. These trends are crucial for comprehending the global landscape of supply chain optimisation and sustainability, emphasising the importance of policy, funding, and collaboration in facilitating progress. Additionally, the graph emphasises the need of investigating how countries with minimal contributions can capitalise on emerging technologies to improve the adaptability and resilience of their supply chains. This research will evaluate how different levels of engagement with AI and sustainable practices influence global progress towards an environmentally conscious and efficient future, while addressing disparities and identifying opportunities for collective development.

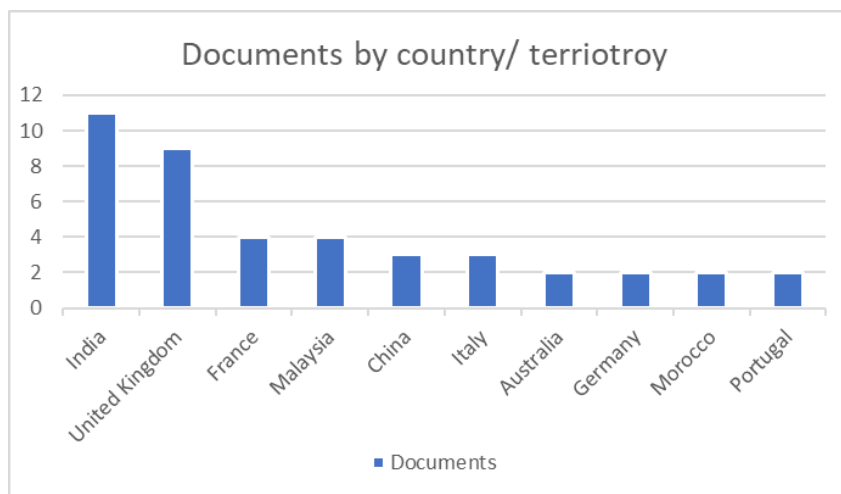


Figure 2: Documents by country/territory

Source: Authors

Within the domain of human-centric technologies, the data visualisation depicted in Figure 3 below, "Documents by Type", offers a concise summary of academic research contributions that are organised by document format. The pie chart provides a concise summary of the preferred mediums for disseminating scholarly knowledge in this field, highlighting the proportion of articles, books, reviews, and book chapters available.

The distribution is dominated by articles, which account for 52% of the total. This indicates their significance as a primary medium for the dissemination of research and academic discourse. This prevalence highlights the importance of disseminating empirical findings and theoretical



advancements via peer-reviewed journals, indicating strong involvement within the academic community. In-depth explorations of human-centric technologies are exemplified by the 21% of contributions that are attributed to books. These extensive resources likely function as fundamental references for both scholarly and professional audiences. Reviews comprise 15% of the documents, underscoring a substantial endeavour to synthesise existing knowledge and assess research trends. This format is indispensable for the purpose of establishing future research agendas and identifying gaps in the field. Finally, book chapters constitute 12% of the publications, indicating collaborative endeavours within edited volumes that focus on particular themes or interdisciplinary investigations.

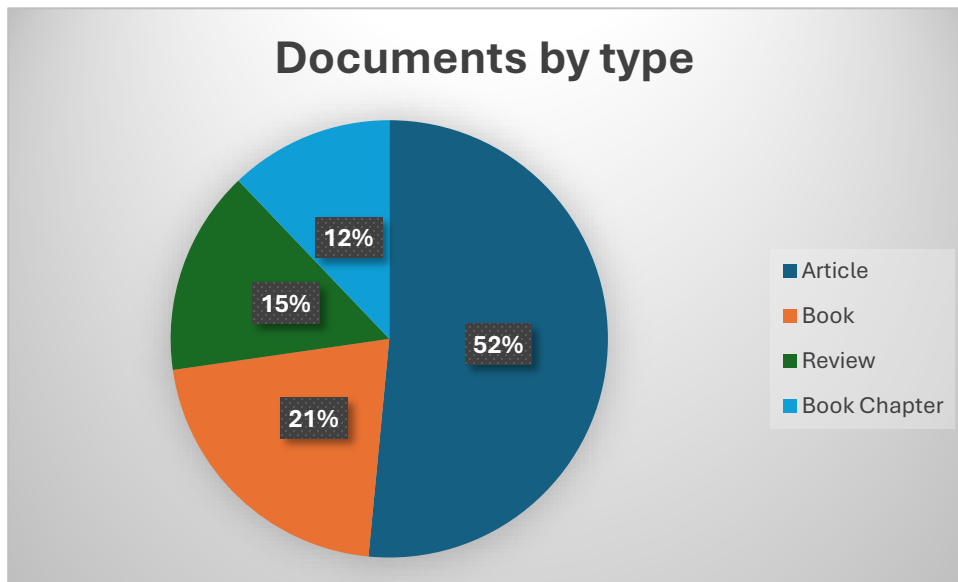


Figure 3: Documents by type

Source: Authors

The below Table 1 labelled presents a comprehensive summary of academic publications that concentrate on the integration of Industry 4.0 and 5.0 technologies. It emphasises the authors, publication titles, years, and citation counts. This summary highlights the increasing emphasis on human-centric and sustainable supply chains, illustrating the rise in scholarly interest in recent years. The paper "Knowledge Mapping of Digital Twin and Physical Internet in Supply Chain Management: A Systematic Literature Review" by Nguyen et al. (2022) is a notable work that has received 85 citations, indicating its significant impact on the exploration of advanced digital technologies. Similarly, Kumar et al. (2023)'s "Effective AI, Blockchain, and E-Governance Applications for Knowledge Discovery and Management", which has been cited 51 times, illustrates the growing significance of blockchain and AI in the advancement of supply chain sustainability.

The academic community's interest in sustainable manufacturing is shown by the high citation counts of works such as "Industry 5.0 Implications for Inclusive Sustainable Manufacturing" by Ghobakhloo et al. (2023), which have received 70 citations. Furthermore, "Intelligent Digital Twin for Supply Chain Stress-Testing" by Ivanov (2023), which received 64 citations, emphasises the significance of digital twins in improving resilience. The emphasis on recent years, particularly 2023, indicates a trend



towards the implementation of human-centric approaches, AI-driven innovations, and sustainability in supply chain management. This corresponds with the research objectives to examine the influence of AI on sustainability and to investigate the function of human-centric technologies in the transition from Industry 4.0 to Industry 5.0.

Table 1: Academic Contributions to Human-Centric and Sustainable Supply Chain Management: A Summary of Key Publications

Authors	Title	Year	Cited by
Atif S.	The role of industry 4.0-enabled data-driven shared platform as an enabler of product-service system in the context of circular economy: A systematic literature review and future research directions	2023	19
Bentalha B.; Hmioui A.; Alla L.	Integrating intelligence and sustainability in supply chains	2023	2
Khan A.A.; Abonyi J.	Information sharing in supply chains – Interoperability in an era of circular economy	2022	33
Shashi; Centobelli P.; Cerchione R.; Ertz M.; Oropallo E.	What we learn is what we earn from sustainable and circular construction	2023	15
Wang S.; Esperança J.P.	Can digital transformation improve market and ESG performance? Evidence from Chinese SMEs	2023	90
Shah A.; Soomro M.A.; Zahid Piprani A.; Yu Z.; Tanveer M.	Sustainable supply chain practices and blockchain technology in garment industry: an empirical study on sustainability aspect	2023	4
Kumar R.; Abdul Hamid A.B.; Binti Ya'akub N.I.	Effective AI, blockchain, and E-governance applications for knowledge discovery and management	2023	51



Priyadarshini J.; Singh R.K.; Mishra R.; Chaudhuri A.; Kamble S.	Supply chain resilience and improving sustainability through additive manufacturing implementation: a systematic literature review and framework	2023	7
Malik M.; Gahlawat V.K.; Mor R.S.	Digital interoperability and transformation using industry 4.0 technologies in the dairy industry: An SLR and bibliometric analysis	2023	0
Behl A.; Singh R.; Pereira V.; Laker B.	Analysis of Industry 4.0 and circular economy enablers: A step towards resilient sustainable operations management	2023	39
Smith C.; Fatorachian H.	COVID-19 and Supply Chain Disruption Management: A Behavioural Economics Perspective and Future Research Direction	2023	4
Al Doghan M.A.; Sundram V.P.K.	Agility and Resilience in Logistics Management: Supply chain optimization	2023	6
Kot S.	Development insights on supply chain management in small and medium-sized enterprises	2023	18
Hallioui A.; Herrou B.; Santos R.S.; Katina P.F.; Egbue O.	Systems-based approach to contemporary business management: An enabler of business sustainability in a context of industry 4.0, circular economy, competitiveness and diverse stakeholders	2022	48



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Mhlanga D.	Responsible Industry 4.0: A Framework for Human-Centered Artificial Intelligence	2023	5
Ojha V.K.; Goyal S.; Chand M.	Study on Data-Driven Decision-Making in Entrepreneurship	2022	3
Irfan M.; Elmogy M.; Majid M.S.A.; El- Sappagh S.	The impact of AI innovation on financial sectors in the era of industry 5.0	2023	17
Ivanov D.	Intelligent digital twin (iDT) for supply chain stress-testing, resilience, and viability	2023	64
Hautala-Kankaanpää T.	Complementary and contingent value of SMEs' data capability and supply chain capability in the competitive environment	2023	2
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Dolgui A.; Ivanov D.	Metaverse supply chain and operations management	2023	38
Narkhede G.; Pasi B.; Rajhans N.; Kulkarni A.	Industry 5.0 and the future of sustainable manufacturing: A systematic literature review	2023	18
Larsson A.; Hatzigeorgiou A.	Designing Smart and Resilient Cities for a Post-Pandemic World: Metropandemic Revolution	2022	1
Kumar A.; Naz F.; Luthra S.; Vashistha R.; Kumar V.; Garza- Reyes J.A.; Chhabra D.	Digging DEEP: Futuristic building blocks of omni-channel healthcare supply chains resiliency using machine learning approach	2023	12
	Compilation of references	2023	0
Nguyen T.; Duong Q.H.; Nguyen T.V.; Zhu Y.; Zhou L.	Knowledge mapping of digital twin and physical internet in Supply Chain Management: A systematic literature review	2022	85
Bakhshi Movahed A.; Bakhshi Movahed A.; Nozari H.	Opportunities and challenges of smart supply chain in industry 5.0	2023	7
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	Digital Era: A Review and Future Research Directions		

Source: Authors

Thematic Analysis

The below figure 4, labelled “word cloud” provides a visual representation of the most frequently occurring terms in the research field is provided by the word cloud generated from the keywords related to human-centric technologies. The visible display of these keywords in different sizes and colours facilitates the rapid identification of the main areas of concentration and the relative significance of different concepts within the domain. The central function of recent research is indicated by the prominent inclusion of terms such as “Industry 4.0” and “Industry 5.0” in the word cloud. These phrases represent the considerable focus on technical progress and shifts from Industry 4.0, which emphasises automation and data interchange, to Industry 5.0, which combines human-centered approaches and collaboration with modern technologies.

Additional important terms include “Sustainability”, “Human-robot collaboration”, and “Digitalisation”. The significance of “Digitalisation” emphasises the extensive implementation and integration of digital technologies in diverse industrial and organisational procedures. This indicates an increasing acknowledgement of the significance of digital transformation in attaining effectiveness and novelty. The terms “Human-computer interaction” and “Human-robot collaboration” are also profoundly highlighted, emphasising the growing emphasis on collaborative technologies that improve human-machine connection. This signifies a transition towards technologically advanced solutions that are more integrated and focused on human needs. It involves utilising the combined power of human abilities with advanced robotics or computer systems to improve productivity and achieve better results.

The visual representation of the most frequently occurring terms in the research field, as generated from keywords in research abstracts, is depicted in the below figure 4, titled “Word Cloud”. The variation in word size and colour enables the summary recognition of prevailing themes and their relative significance within the field. The prominence of terms such as “supply chain”, “management”, “sustainable”, “research”, and “industry” is indicative of the central focus of contemporary research. The importance of “supply chain” and “management” highlights the discipline’s emphasis on optimising and innovating processes to improve operational efficiency and effectiveness. These terms signify an increasing focus on supply chain management as a fundamental field of study.

Some of the most significant terms, including “sustainable”, “digital”, and “study”, emphasise critical areas of interest. The term “sustainable” highlights the sensitive focus on environmental and social accountability, indicating the rising importance of sustainability in research and practice. The term “digital” signifies the extensive impact of digital transformation and technological integration in encouraging innovation and efficiency across multiple sectors. Additionally, terms like “research” and “industry” imply a convergence between academic inquiry and practical application, connecting theoretical frameworks with real-world opportunities and challenges. This dual emphasis guarantees that research improves academic knowledge while providing practical insights for industries. The visualisation emphasises the interrelation of sustainability, digitalisation, and supply chain management within the wider industrial and research frameworks. It signifies the industry’s

development towards more sustainable, technologically sophisticated, and adaptable methodologies to effectively tackle modern challenges.



Figure 4: Word cloud

Source: Authors

Table 2: Main themes, Sub themes and Supporting Quotes

Main Theme	Subthemes	Supporting Quotes
  AI-Driven Analytics	Predictive	Improving demand forecasting and inventory optimisation.
		“AI-driven predictive analytics improves demand accuracy by uncovering hidden patterns in historical data.” (Belhadi et al., 2021)
		“Optimized inventory levels can be achieved through AI’s ability to predict demand fluctuations precisely...” (Singh, 2023)
		“Advanced analytics can minimize overstocking and stockouts, improving overall supply chain efficiency...” (Lücker & Seifert, 2017)
		“Integrating AI into inventory management systems reduces lead times and improves responsiveness...” (Marinagi et al., 2023)
		“AI improves supply chain planning by accurately matching supply with demand...” (Modgil et al., 2021)
		Mitigating supply chain disruptions through predictive risk analysis.
		“AI enables real-time risk identification and mitigation strategies, strengthening supply chain resilience...” (Lokanan & Maddhesia, 2022)
		“Predictive analytics identifies potential supply chain bottlenecks before they occur...” (Ye, 2023)
		“AI’s predictive capabilities allow for proactive risk management in volatile environments...” (Ivanov et al., 2021)
		“AI-driven solutions improve decision-making during disruptions like COVID-19...” (Queiroz et al., 2022)
		“Predictive tools improve the ability to address unforeseen challenges effectively...” (Modgil et al., 2021)
		Reducing operational inefficiencies and the bullwhip effect.
		“AI applications alleviate the bullwhip effect by improving information flow and demand visibility...” (Belhadi et al., 2021b)
		“Machine learning algorithms reduce operational inefficiencies by optimizing production schedules...” (Singh, 2023)
		“AI-driven tools improve supply chain coordination, reducing variability in demand forecasts...” (Zhu et al., 2018)
		“Operational inefficiencies linked to poor forecasting are mitigated through AI-powered insights...” (Wang, 2022)
		“Big data and AI improve coordination across supply chain tiers, reducing inefficiencies...” (Marinagi et al., 2023)
Human-Centric Technologies	Improving collaboration between human intelligence and AI in supply chain decision-making.	“Human-AI collaboration improves strategic decision-making in complex supply chain scenarios...” (Nyamekye, 2023)
		“Integrating human feedback into AI systems ensures better contextual decision-making...” (Nikookar & Yanadori, 2021)
		“AI supports human creativity by providing actionable insights, encouraging innovation...” (Ekellem, 2023)
		“Effective collaboration between AI and humans drives operational efficiency and adaptability...” (Wieland & Durach, 2021)



		"Human-centric technologies enable the co-creation of solutions for supply chain challenges...". (Fraga-Lamas et al., 2021)
	Improving worker well-being and job satisfaction through human-centric designs.	"Human-centric technologies prioritize worker safety and satisfaction in Industry 5.0 environments...". (Mourtzis et al., 2022)
		"Technology that aligns with human values encourages a more inclusive and supportive work environment...". (Onyemelukwe, 2023)
		"Human-centric systems balance automation with job enrichment, improving morale...". (Athinarayanan, 2023)
		"Worker-friendly designs improve operational outcomes while ensuring sustainability...". (Purwandaru, 2023)
		"AI and robotics improve workplace safety by handling repetitive or dangerous tasks...". (Fraga-Lamas et al., 2021)
	Integrating human feedback into AI-driven supply chain processes.	"Human feedback improves the accuracy and relevance of AI-driven supply chain solutions...". (Singh, 2023)
		"AI systems improve significantly when aligned with human expertise and real-world insights...". (Nikookar & Yanadori, 2021)
		"Feedback loops between humans and AI systems ensure continuous improvement in SCM...". (Wieland & Durach, 2021)
		"AI-human integration encourages innovation and problem-solving in dynamic supply chains...". (Ekellem, 2023)
Sustainability in Supply Chain Management	Integrating AI to achieve environmental sustainability through resource efficiency.	"Integrating user feedback into AI systems ensures solutions are practical and contextually suitable...". (Fraga-Lamas et al., 2021)
		"AI enables efficient resource allocation, reducing environmental impact and waste...". (Sanders et al., 2019)
		"Sustainability objectives are met through AI's precision in resource management...". (Abbasi et al., 2016)
		"AI-driven solutions align supply chains with global sustainability goals...". (Bui et al., 2021)
		"AI optimizes energy use in logistics, minimizing carbon emissions...". (Zhu & Wu, 2022)
	Promoting the circular economy with AI-enabled waste reduction and recycling initiatives.	"AI systems enable supply chains to achieve long-term environmental and economic goals...". (Busse et al., 2016)
		"AI supports circular economy principles by enabling efficient waste management and recycling...". (Atif, 2023)
		"AI-driven predictive analytics improves resource recovery and reuse...". (Belhadi et al., 2021b)
		"AI's capabilities align with circular economy practices, ensuring sustainability...". (Fraga-Lamas et al., 2021)
		"Recycling initiatives benefit from AI-driven optimisation of supply chain operations...". (Hsu, 2021)
		"AI enables better integration of recycling into supply chain processes...". (Sanders et al., 2019)



	Aligning supply chain practices with global sustainability standards and metrics.	"AI integrates sustainability metrics into decision-making processes..." (Zhu et al., 2018)
		"AI-enabled transparency ensures adherence to global sustainability standards..." (Yerpude et al., 2022)
		"Global standards are met through AI's ability to manage complex sustainability metrics..." (Busse et al., 2016)
		"AI-driven SCM promotes alignment with environmental policies and regulations..." (Kazançoğlu et al., 2018)
		"Sustainability metrics are more effectively implemented with AI systems..." (Wang, 2022)

Source: Authors

5. Discussion



Figure 5: Main themes, subthemes

Source: Authors

Theme One: AI-Driven Predictive Analytics



Demand forecasting accuracy has been demonstrated to be significantly improved by AI technologies, particularly machine learning (ML) and predictive analytics. For example, research suggests that AI has the capacity to analyse extensive datasets in order to identify patterns and trends, thereby enabling more accurate market demand predictions (Eyo-Udo, 2024). The production planning process is streamlined as a result of this improved forecasting capability, which not only reduces inventory holding costs but also minimises stockouts (Adenekan, 2024).

Additionally, the integration of AI into inventory management enables the optimisation of stock levels and the improvement of overall supply chain efficiency through dynamic adjustments that are based on real-time data (Muthaluri, 2024).

The utilisation of predictive risk analysis to mitigate supply chain disruptions is a critical function of AI in reducing supply chain interruptions. Historical data and current market conditions can be analysed by AI systems to identify potential risks and vulnerabilities within the supply chain (Bidin, 2024; Nzeako, 2024). For instance, organisations that implemented artificial intelligence (AI) for risk management were more adept at adapting to abrupt modifications and disruptions during the COVID-19 pandemic (Modgil *et al.*, 2021b; Bidin, 2024). Predictive analytics allows organisations to proactively evaluate risks and implement strategies that improve resilience, such as optimising logistics routes or diversifying suppliers (Joel, 2024). This proactive approach not only protects against disruptions but also improves the resilience of the supply chain, enabling it to adjust to unforeseen challenges (Shekhar, 2023).

AI-driven solutions are important in reducing operational inefficiencies and mitigating the bullwhip effect, a phenomenon in which small fluctuations in demand at the retail level cause larger fluctuations up the supply chain (Muthaluri, 2024). Organisations can facilitate improved visibility and coordination throughout the supply chain by implementing AI algorithms for real-time data analysis and demand forecasting (Eyo-Udo, 2024). This transparency facilitates improved alignment between supply and demand, consequently decreasing surplus inventory and mitigating waste (Atadoga, 2024). AI's ability to optimise transportation routes and logistics also improves delivery efficiency, which lowers operating costs and increases customer satisfaction (Eyo-Udo, 2024).

Theme Two: Human-Centric Technologies

The collaboration between AI and human intelligence is crucial for improving the adaptability and resilience of the supply chain. Artificial intelligence technologies, including predictive analytics and machine learning, can markedly improve decision-making through real-time data analysis and forecasting abilities. Modgil *et al.* (2021b) emphasise that AI can improve strategic planning and optimise workforce allocation, thus improving organisational performance and supply chain resilience during disruptions such as those experienced during the COVID-19 pandemic. Furthermore, the integration of AI into supply chain processes enables improved coordination and information flow, which is key for the effective formulation of decisions (Atadoga, 2024). This synergy improves operational efficiency and enables organisations to respond quicker to market changes, which encourages a more agile supply chain environment (Atadoga, 2024).

To improve the satisfaction and well-being of employees, it is imperative to implement human-centric designs in supply chain management. The requirement to evaluate the social consequences of technological advancements on workers, particularly in vulnerable sectors, is further emphasised by



the concept of a “just transition” (Karaosman, 2024). Human-centric approaches can be prioritised by organisations to establish work environments that improve employee engagement and satisfaction. For example, AI-driven solutions can be developed to augment rather than replace human workers, enabling them to concentrate on more strategic responsibilities that demand critical thinking and creativity (Dash *et al.*, 2019). This method not only improves job satisfaction but also cultivates a culture of collaboration in which the strengths of human workers and AI systems are complemented (Adenekan, 2024). Additionally, the implementation of a thoughtful design approach to health and safety concerns can result in a more motivated workforce, which in turn improves organisational performance (Karaosman & Marshall, 2023).

It is imperative to incorporate human feedback into AI-driven supply chain processes to guarantee that AI systems remain consistent with human values and operational realities. The accuracy of AI models can be improved through human feedback, resulting in improved forecasting and decision-making outcomes (Nzeako, 2024). Integrating employee insights into AI algorithms can improve predictive analytics, rendering them more pertinent and effective in practical applications (Adenekan, 2024). Furthermore, the iterative process of incorporating human feedback cultivates a culture of continuous improvement, in which AI systems develop in response to operational challenges and user experiences (Sullivan & Wamba, 2022). This not only improves the efficiency of AI in supply chain management but also empowers employees by enabling them to actively participate in the technological transformation of their workplaces (Olan *et al.*, 2021).

Theme Three: Sustainability in Supply Chain Management

Supply chain management is increasingly acknowledged as a critical strategy for achieving environmental sustainability by improving resource efficiency through the integration of Artificial Intelligence (AI). AI technologies make it easier to optimise resource use, which is key for cutting down on waste and carbon emissions. AI-driven predictive analytics can improve decision-making in resource allocation, resulting in improved operational efficiency and diminished environmental impacts (Akter, 2024b; Hasas, 2024). Akter (2024a) emphasise the importance of AI in improving operational efficiency and data accuracy, which are critical components of sustainable practices in a variety of sectors, such as agriculture and manufacturing.

Furthermore, initiatives that are enabled by artificial intelligence (AI) to reduce waste and recycle are a significant incentive to advance a circular economy. The volume of materials that can be effectively recycled can be increased by improving the accuracy and efficiency of sorting processes, which can be achieved through the use of AI technologies (Ayoubi, 2023; Naeeni, 2023a). For instance, AI systems have the capacity to analyse waste streams in real-time, identifying recyclable materials and optimising collection routes to reduce emissions during transport (Varghese, 2022). This conserves resources by enabling the reuse of materials, which is a fundamental principle of the circular economy, in addition to reducing landfill waste (Yiğitcanlar, 2021). The integration of AI into waste management is consistent with global sustainability objectives, as it encourages a more responsible approach to waste generation and resource consumption (Okoye, 2024).

Another critical component of the integration of AI into supply chain management is the alignment of supply chain practices with global sustainability standards and metrics. Standardised metrics enable organisations to efficiently evaluate their sustainability performance and pinpoint areas for development (Islam, 2024; Venkatarman, 2024). AI can facilitate this alignment by delivering real-



time analytics and insights that assist organisations in complying with sustainability standards, including those established by the United Nations Sustainable Development Goals (SDGs) (Yiğitcanlar, 2021; Islam, 2024). Furthermore, AI-driven solutions can improve transparency in supply chains, allowing stakeholders to monitor sustainability metrics and guarantee adherence to environmental regulations (Wynsberghe, 2021). This transparency is key for establishing trust with consumers and investors, who are increasingly prioritising sustainability in their decision-making processes (Okoye, 2024).

Theoretical and Practical Implications

The theoretical understanding of the intersection between AI-driven predictive analytics, human-centric technologies, and sustainability within supply chain management is significantly improved by this study. By situating the research within the transition from Industry 4.0 to Industry 5.0, the results emphasise the significance of integrating human intelligence and advanced predictive capabilities to resolve operational complexities.

The study supports the theoretical frameworks of the Resource-Based View (RBV) and Socio-Technical Systems (STS), illustrating how AI technologies and human-centric approaches collaborate to improve the adaptability and resilience of supply chains. In addition, the theoretical discourse on sustainable practices in industrial systems is advanced by the integration of sustainability metrics, which emphasises an innovative intersection of technology, human welfare, and environmental stewardship.

The findings provide practical insights for organisations that are transitioning from Industry 4.0 to Industry 5.0. The integration of AI-driven predictive analytics is demonstrated to significantly improve operational efficiency, risk mitigation, and demand forecasting, all of which are key for the attainment of supply chain optimisation and sustainability. Furthermore, the emphasis on human-centric technologies lays out a strategy for improving worker well-being, improving collaboration between human and machine intelligence, and integrating ethical practices into supply chain management. The research emphasises the significance of AI in integrating supply chain activities with international sustainability objectives, guaranteeing adherence to environmental regulations while advancing circular economy initiatives. These insights function as a strategic guide for decision-makers who are striving to establish sustainable and resilient supply chains.

Limitations of the study

This study's limitations are indicative of the challenges that are inherent in the examination of the transition from Industry 4.0 to Industry 5.0, with an emphasis on sustainability and AI-driven predictive analytics. The variability in data quality and availability across various industries and regions is a primary challenge. The generalisability of the findings is restricted by this inconsistency, which may obscure valuable insights into the impact of AI on supply chains and the regional and sectoral differences in AI adoption.

Furthermore, despite the transformative potential of AI, its integration is still restricted by technological disparities, particularly in developing regions where access to infrastructure and expertise is restricted. In addition, the human-centric component of the transition to Industry 5.0 introduces challenges in the delicate balance between technological innovation and socio-environmental



concerns. The integration of sustainability metrics into AI systems frequently encounters resistance because of cost constraints and organisational inertia.

Furthermore, the assessment of long-term effects is complicated by ethical and regulatory concerns regarding data privacy, transparency, and bias in AI-driven solutions. These constraints emphasise the need of additional research to develop comprehensive, inclusive frameworks that integrate AI capabilities with sustainability objectives and consider human and environmental factors in a variety of operational settings.

Conclusion and Recommendations

This research emphasises the transformative potential of AI-driven predictive analytics in improving the sustainability and optimisation of supply chains. It emphasises the improvement of forecasting accuracy, the reduction of operational inefficiencies, and the cultivation of resilience in supply chains because of advanced AI technologies. These technologies facilitate precise resource management, alignment with sustainability metrics, and strong risk mitigation strategies, thereby guaranteeing adaptability during transitions such as those occurring during the COVID-19 pandemic. In addition, the integration of AI with circular economy principles facilitates the reduction of waste and the recycling of materials, thereby promoting long-term environmental objectives and global sustainability standards. Concurrently, the investigation highlights the critical role of human-centric technologies in the transition from Industry 4.0 to Industry 5.0. These technologies promote collaboration between AI and human intelligence, thereby improving operational efficiency and decision-making. By emphasising employee welfare and integrating human input into AI systems, organisations can harmonise automation with ethical and inclusive practices, promoting sustainability and innovation. A resilient, adaptive, and sustainable supply chain ecosystem is guaranteed by the alignment of innovations in technology with human-centric approaches.

Future research should further investigate the integration of AI with sustainable and human-centric supply chain systems. A significant contribution to the advancement of Industry 5.0 principles will be made by investigating methods to balance automation with human creativity, emotional intelligence, and ethical considerations in decision-making. Research is required to create frameworks that prioritise worker well-being, inclusivity, and job satisfaction, particularly in industries that are in the process of transitioning, while also incorporating AI-driven analytics. The assessment of the long-term social consequences of AI on workforce dynamics will offer key insights into guaranteeing equitable growth during this industrial transformation.

Furthermore, the field of sustainability continues to be a critical area for future investigation. Supply chains can be further aligned with global sustainability standards by investigating AI's role in promoting circular economy initiatives, such as waste reduction and recycling. The adoption of greener supply chain practices will be facilitated by research on how AI can facilitate real-time monitoring and optimisation of environmental metrics. A comparative analysis of regional and sectoral differences in the implementation of AI-driven sustainability practices can also provide insight into scalable solutions for diverse supply chain contexts, thereby bridging the gap between technological development and ecological stewardship.

Actionable steps are required to ensure that AI technologies are in alignment with sustainability objectives during the transition from Industry 4.0 to Industry 5.0. Organisations should prioritise the



integration of AI-driven predictive analytics to improve the efficiency and resilience of their supply chains. This encompasses the implementation of artificial intelligence (AI) tools to optimise resource utilisation, minimise waste, and forecast demand in real time. The implementation of circular economy practices that are enabled by AI, such as sustainable inventory management and advanced recycling initiatives, can contribute to the development of environmental sustainability. Furthermore, the integration of sustainability metrics into AI systems guarantees compliance with international standards and enables transparent, data-driven decision-making, thereby promoting a harmonious equilibrium between economic, environmental, and social imperatives.

An equally critical component of this transition is a human-centric approach. Organisations should prioritise the utilisation of AI-human collaboration to improve adaptability and promote innovation in dynamic supply chains. The process entails the development of AI systems that incorporate human feedback to improve operational relevance and contextual decision-making. Improving employee well-being via human-centric technology, including the automation of repetitive tasks while augmenting human roles, can elevate job satisfaction and productivity. The alignment of technological advancements with societal and environmental objectives is emphasised by the establishment of continuous feedback loops between AI systems and employees, which guarantees practical, sustainable, and socially responsible solutions.



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The Role of Water Governance Quality and Institutional Capacity on Facilitating Climate Change Adaptation: A Case of Selected Water Institutions within the Eastern Cape

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ABSTRACT

Climate change has continued to have ripple effects on developing countries. However, many studies suggest that climate change adaptation poses its own challenges, which may lead to uncertainty in the future. Moreover, most developing countries are still finding it challenging to adapt to climate change hence, many researchers argue that governance institutions become critical towards adapting to climate change. The country is becoming increasingly vulnerable to the impacts of climate change, including rising temperatures, destructive storms, and a decrease in rainfall. Considering such trends, the country's government later established the National Climate Change Response White Paper of 2011 and the National Climate Change Adaptation Strategy of 2020. The study adopted the negative consumer satisfaction theory as theoretical lens for the study. Furthermore, the study area is the Eastern Cape Province. The province has two metropolitan municipalities and six district municipalities, which are further divided into 29 local municipalities. Moreover, the local government institutions of the province are suffering from limited skills and capacity to adapt to climate change. The study employed an exploratory research design, which was necessitated by the qualitative research method. The data for the study were collected in 2025. The selected institutions within the province included municipalities and water service providers, which are essential to the scope of water governance. A total of 18 research participants from three different water institutions were interviewed in the study. The study employed interviews to collect primary data. The study employed semi-structured interviews to uncover institutional capacity challenges in the province. The study also utilized secondary data to complement the primary data, in the form of government gazettes, reports, and archives. The study further employed thematic analysis to analyse the qualitative data obtained. The study's findings reveal that there insufficient municipal staff and maintenance problems hinder water supply, conflicting water licensing priorities challenge governance coordination, the lack of capacity hinders climate change adaptation at municipalities, the lack of climate change conditional grants amongst others. Furthermore, recommendations of the study reveal community initiatives, institutional capacity building, and artificial intelligence.

Keywords: water governance quality; climate change adaptation; negative consumer satisfaction theory; adaptive capacity; local government



1.1 INTRODUCTION AND BACKGROUND

Climate change has continued to have ripple effects on developing countries (Kom et al., 2022). However, a study by Petzold et al. (2020) suggests that climate change adaptation poses its own challenges, which may lead to uncertainty in the future. Moreover, most developing countries are still finding it challenging to adapt to climate change hence, many researchers argue that governance institutions become critical towards adapting to climate change (Landauer, Juhola, & Klein, 2019; Mews et al., 2019; Hosen et al., 2020), as these institutions are leading the fight against climate change impacts (Birchall & Bonnett, 2021). Similarly, a study by Dale et al. (2020) states that local government institutions worldwide are adapting to climate change within their respective areas of governance.

Regmi and Bhandari (2013) still argued that there were many conflicting ideas on the increase in climate change adaptation, more especially on how it can be measured. However, monitoring and evaluating climate change responses are considered important for the development of climate change adaptation strategies that aim to enhance implementation (Morecroft et al., 2019; Singh et al., 2022). Alternatively, many researchers suggest that initiatives such as metrics, techniques, frameworks, and indicators can be used to measure climate change adaptation (Fu et al., 2012; Siders, 2019; Simpson et al., 2021; Singh et al., 2022). Additionally, there is an agreement on the lack of tools that systematically evaluate the quality of institutional water governance in relation to climate change adaptation. Moreover, many scholars argue that addressing adaptive capacity to climate change is a challenging task (Engle, 2011; Patterson & Huitema, 2019), often attributed to the poor adaptive capabilities of local authorities (Mikulewicz, 2018; Siders, 2019).

Nevertheless, numerous climate change-related problems are associated with local government institutions, as outlined by Nhamo & Agyepong (2019). For instance, the City of Cape Town, situated in the Western Cape Province, has experienced severe water shortages due to prolonged drought conditions over the years (Bai et al., 2018; Dube, Nhamo, & Chikodzi, 2022). Additionally, the eThekweni Metropolitan Municipality is considered one of the leading municipalities in terms of institutional adaptation to climate change at the local level (Leck & Roberts, 2015; Leck & Simon, 2018; Rosendo, Celliers, & Mechisso, 2018). This municipality has also struggled to deal with heavy rainfall. In addition, most local government institutions within the Province of the Eastern Cape have continued to face challenges related to adaptation to the effects of climate change (Santhia, Shackleton, & Pereira, 2018), notwithstanding the effects of severe drought that have affected the province over the years (Walz et al., 2020). Although there is extensive knowledge on the challenges of climate change adaptation by municipalities within the country, the government has prioritized research to design a system that evaluates climate change adaptation from a national government perspective (Ziergovel et al., 2014). Additionally, similar to other states, the country faces challenges resulting from its limited experience with evaluating and monitoring climate change (Ziergobel et al., 2014). Thus, scholars such as Averchenkova, Gannon, and Curran (2019) argue that the country requires a comprehensive reporting and evaluation system with clear indicators that will adequately address the impacts of climate change.

In mentioning the above challenges, some lawmakers that include Ofoegbu et al. (2016) investigated and evaluated, Mpandeli et al. (2019) and Nyide et al. (2023) investigated and evaluated the issue of



adaptive governance to climate change in the country and proposed strategies that seek to meet the threats posed by climate change towards livelihoods. Nonetheless, the literature lacks an understanding of the role of water governance quality in climate change adaptation at the local government level. Considering this gap, this article employs the Negative Consumer Satisfaction Theory as the theoretical framework for the study. This theory posits that when municipalities are unable to provide any services to the public, most communities often feel the impact of those institutional issues. The objectives of the article were derived from the theory that include (i) assessing the role of water governance quality on climate change adaptation within the province of the Eastern Cape; (ii) understanding the institutional capacity challenges affecting municipalities from adapting to climate change; (iii) establishing the link between water governance quality, Institutional capacity and climate change adaptation in the country.

1.2 THE PROBLEM

The local government in South Africa comprises metropolitan, district, and local municipalities. It should be understood that the district municipalities have local municipalities which are under their jurisdiction (Leck & Simon, 2018). These scholars argue that most municipalities have provided climate change initiatives, but district and local municipalities still struggle. All district municipalities, through the assistance of the South African Local Government Association (SALGA), have designed climate change policies. Nonetheless, numerous researchers, such as Ziergovel et al. (2014), have demonstrated that most municipalities struggle to implement climate change adaptation due to inadequate climate modelling techniques. Furthermore, there are minimal climate change adaptation initiatives at local municipalities within the country (Nkonjera, 2017). Scholars like Ziergovel et al. (2014) and Montmasson-Clair and Zwane (2016) state that most municipalities are still facing challenges related to climate change which include lack of political will, poor overall performance by municipalities (Pasquini, Owling, & Ziergovel, 2013), and lack of financial resources (Rosendo, Celliers, & Mechisso, 2018), lack of human capacity (Rosendo et al., 2018), limited skills and expertise (Ziergovel et al., 2014), lack of knowledge and information (Rosendo et al., 2018), lack of positioning of climate change within local government institutions (Santhia et al., 2018), and poor coordination (Ziergovel et al., 2014; Santhia et al., 2018).

1.3 RESEARCH OBJECTIVES

The objectives of the article were derived from the theory that include:

- Assessing the role of water governance quality on climate change adaptation within the province of the Eastern Cape
- Understanding the institutional capacity challenges affecting municipalities from adapting to climate change
- Establishing the link between water governance quality, Institutional capacity and climate change adaptation in the country.

2. LITERATURE REVIEW

2.1 Theoretical Framework

The negative consumer satisfaction theory



At the heart of the negative consumer satisfaction theory lies the understanding that a consumer's satisfaction or dissatisfaction is based on their past experiences (Rana, 2023). The theory's main principles are informed by poor satisfaction with services (Rana, 2023). The theory was developed to understand how expectation discrepancies result in adverse outcomes (Rana, 2023). A great deal of dissatisfaction occurs when consumers perceive performance as being below their expectations. This study employed this theory because there is excellent dissatisfaction when customers' expectations are not met, which often affects their lives to some extent (Vavra, 1997). As a result, the theory presented in this study aims to explain the dissatisfaction that usually arises due to service providers failing to meet consumers' expectations. Customers in this sense are community members, citizens, or inhabitants of a specific region with a constitutional obligation to obtain water services under Section 27(1)(b) of South Africa's Constitution, 1996.

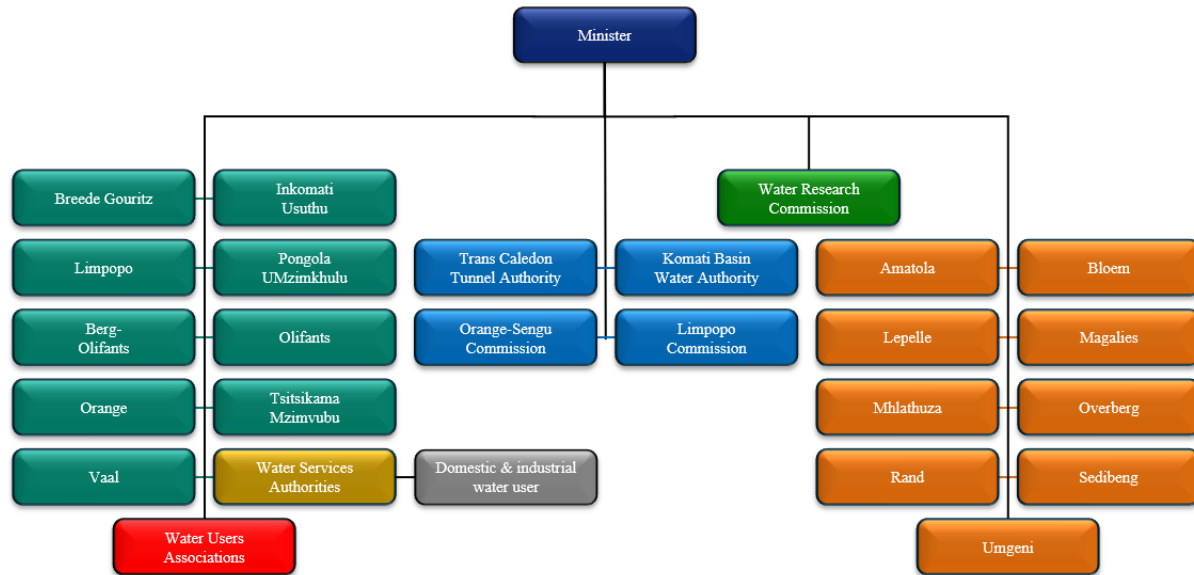
Meanwhile, municipalities are seen as providing essential services such as water. As a result, the study employed this theory to explain how citizens may be affected when the government is unable to offer services sustainably. Water is one example of an essential service. The theory explains that end users bear the brunt when expectations are not met. A great deal of dissatisfaction will arise when service providers (the government) fail to meet the expected performance (Carlsmith & Aronson, 1963). However, feelings towards a service will be determined by the dissatisfaction that comes with the service (Vavra, 1997). Therefore, this study concludes that the public sector's failure to supply water to citizens efficiently is an inescapable inconvenience. It has significant consequences for household activities.

Every business or institution must adhere to customers' needs and wants. There is generally one thing that consumers will never compromise, and that is their satisfaction (Rana, 2023). Most consumers become loyal to an institution or business when treated well (Rana, 2023). This theory is relevant to this study due to the dissatisfaction that often arises whenever municipalities do not provide water consistently. The study employed this theory to understand how municipalities are required by law to supply water to residents, and what happens to residents whenever that water is not received. This often occurs among consumers, in this case, rural communities, and their dissatisfaction is usually accompanied by violent service delivery protests. These protests generally display citizens' dissatisfaction when their essential services are not met. Therefore, this study used the negative consumer satisfaction theory to examine how satisfaction and dissatisfaction are based on experiences of what rural communities go through when there is a poor water supply.

2.2 Conceptual Literature Review

a. Water governance in South Africa

Other external parties, such as the commercial sector and community-based organisations, provide support mechanisms for the state, which is South Africa's only water supplier. Muller (2006) and Qumbu (2021) state that the institutional developments in the South African water sector are a source of concern. Local governments are responsible for maintaining treated water taps, while the DWS oversees the supply of water from rivers and subterranean sources.



Source: Mbongwa (2019)

Figure 1: The water sector in the country

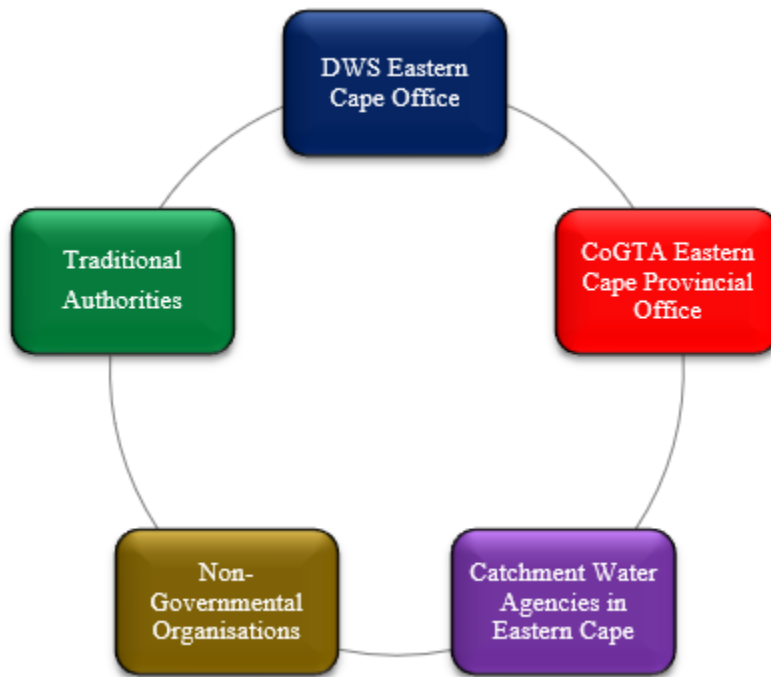
Figure 1 above clearly shows the water sector within the country. This reform was shaped by 20 years of failing to fulfil their mandate of providing water to address racial and gender discrimination (Balzer, 2018). On the figure's far left are the water user associations (WUAs) from the nine water catchment areas, which have a claim to irrigation, recreation, and conservation rights within the catchment areas. Then, the water service authorities (WSAs) must supply water to communities.

According to Aarnoudse, Closas and Lefore (2018), WUAs must improve their operations and exert more control over the WSAs. On the far right of Figure 1 are the water boards. These government-run organisations work to provide bulk water services to local authorities. Political influence is one of the key elements affecting the policies that guide water boards. A key component of the figure is the Water Research Commission (WRC), which is at the forefront of setting the agenda for research, development, and policy innovation. Other water institutions supervise the management of water resources and the implementation of international water accords. The State Water Service Framework was created with the intention of preventing people from using unapproved and unsupervised water, which can cause illness (Qumbu, 2021). This supports the government's responsibility in providing water services. Since individuals already consume contaminated water from municipal supplies and go for extended periods without access to water, it is assumed that the state cannot offer adequate and trustworthy oversight of water resources on its own (Qumbu, 2021). Many families lack the necessary infrastructure to make up for water shortages. Communities sometimes attempt to emulate a province where community members banded together to restore a damaged community borehole; however, the community was not permitted to repair the well by the Mokgalakwena Municipality (South African Human Rights Commission (SAHRC), 2021).



b. Water governance in the Eastern Cape

Like many parts of South Africa, the Eastern Cape Province is a complex region that involves a range of institutions and structures responsible for managing and regulating water resources (Department of Water and Sanitation Report, 2024). The province faces challenges that include droughts, water scarcity, and unequal access to water (DWS, 2024). Below are some key governance structures and institutions involved in managing water in the province.



Source: Researcher's own configuration (2025)

Figure 2: Water governance institutions and structures in the Eastern Cape

Department of Water and Sanitation (DWS)

The Department of Water and Sanitation (DWS) is a national institution responsible for water management, policy formation, and overall governance (DWS, 2024). This department oversees water-related laws and policies across South Africa, including the Eastern Cape (DWS, 2024). The department is responsible for ensuring water security, managing water quality, and setting water tariffs and regulations regarding water use (DWS, 2024). The department also collaborates with local and provincial institutions to manage the distribution and quality of water (DWS, 2024).

Provincial government (Eastern Cape Department of Co-Operative Governance and Traditional Affairs (CoGTA))

The provincial government supports local municipalities through governance and service delivery, which includes water and sanitation (CoGTA, 2020). The provincial government is responsible for ensuring that provincial-level policies are implemented, that municipal services are coordinated,



including water supply and infrastructure maintenance, and that local authorities comply with national water regulations (CoGTA, 2020).

Catchment management agencies (CMAs)

The CMAs are important in South Africa's water governance framework. These agencies operate from a regional level and manage water resources within specific river catchments (DWS, 2024). The Eastern Cape Province has two CMAs under its jurisdiction: Orange Senqu CMA, which covers the part of the Eastern Cape that falls under the Orange River system, and Mzimvubu-Tsitsikamma CMA, which manages water resources in the Mzimvubu-Tsitsikamma areas (DWS, 2024). These agencies are tasked with implementing integrated water resource management, which ensures equitable access to water, protects water ecosystems, and promotes sustainable water use (DWS, 2024).

Non-governmental organisations (NGOs)

NGOs within the Eastern Cape Province play an essential role in advocating for better water governance, promoting community-based water management organisations, and addressing issues related to water access and sanitation in geographical locations (Motloun, 2024). For instance, organisations in the Eastern Cape, such as the Eastern Cape Water Caucus and the South African Water Caucus, are in place to ensure that water policies are implemented in ways that prioritise environmental sustainability, equity, and social justice (Motloun, 2024).

Traditional authorities

In some parts of the province, more especially in rural communities, water governance involves traditional leaders who assist in mediating water distribution and ensure that local communities are addressed (Henn, 2023). Traditional authorities typically provide oversight roles in water use in rural communities, ensuring that local customs and practices around water management are respected and providing support for water policies at the local level (Henn, 2023).

c. Water governance structures and institutions at CHDM

Chris Hani District Municipality (CHDM)

The CHDM coordinates and oversees water and sanitation services across the local municipalities within its jurisdiction (CHDM IDP 2022/2023). While local municipalities are responsible for direct water supply, the district plays a prominent role in strategic planning and budgeting. It ensures that services are extended to all areas within the district (CHDM IDP, 2022/2023). The CHDM plays a crucial role in monitoring water quality, coordinating water infrastructure projects, and assisting local municipalities in maintaining and repairing water supply systems (CHDM IDP, 2022/2023).

Local municipalities within CHDM

The district comprises five local municipalities: Elloitdale, Instika Yethu, Inxuba Yethemba, Amahlathi, and Siyancuma (CHDM IDP, 2022/2023). Each of these municipalities is responsible for managing the local water supply (CHDM IDP, 2022/2023). These municipalities often collaborate with provincial and national agencies to ensure adequate water services (CHDM IDP, 2022/2023).

2.3 Empirical Literature Review

Adaptive Capacity to Climate Change: Global Perspective



According to Simpson et al. (2021), there is no consensus or standardised framework for evaluating adaptive capacity in relation to climate change. However, many European countries have adopted adaptive capabilities that include a scenario-driven model, which seeks to assess the global aspects of the countries (Acosta et al., 2013). Nevertheless, other scholars argue that adaptive capacity must be assessed from a local perspective (Amaru & Chhetri, 2013). Countries such as Mozambique, Uganda, and Ethiopia have adopted a local adaptive framework and indicators used to assess climate change adaptation within households and communities (Mesfin et al., 2020). Additionally, countries within the Caribbean have utilized an indicator index to assess their adaptive capacity (Lam et al., 2014). Moreover, Chile developed a scenario-driven model aimed at enhancing the adaptive capacity of nine local government institutions to climate change (Acosta et al., 2013). Furthermore, the adaptation to climate change has been researched in countries such as Canada (Pickering et al., 2015) and Ghana (Williams et al., 2019), as well as in some agricultural industries within countries like Mexico (Maldonado-Mendez, Romo-Lozano, & Monterroso-Rivas, 2022).

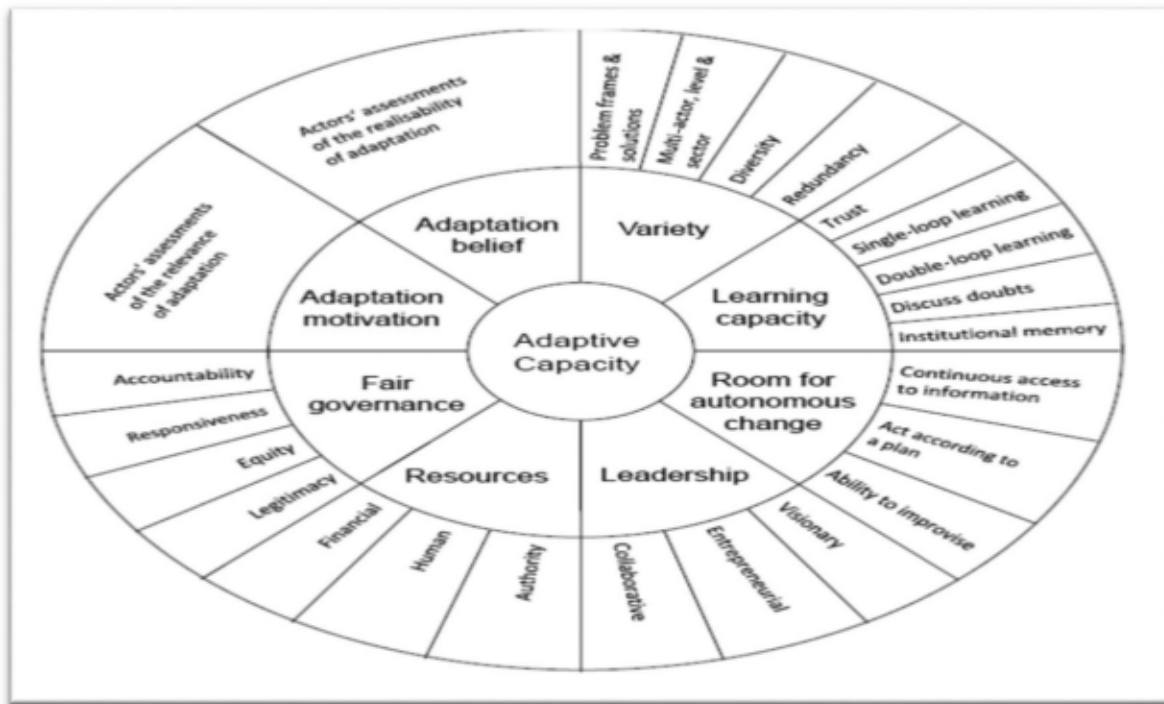


Figure 3: Extended adaptive capacity wheel

Source: Grothmann et al. (2013)

The country is becoming increasingly vulnerable to the impacts of climate change, including rising temperatures, destructive storms, and a decrease in rainfall (Wales, Nkoana, & Mkuna, 2022). Considering such trends, the country's government later established the National Climate Change Response White Paper of 2011 and the National Climate Change Adaptation Strategy of 2020. Similarly, scholars such as Leck and Simon (2018) note that considerable attention has been given to climate change, accompanied by an increase in policy initiatives. Averchenkova, Gannon, and Curran (2019) further support the view that the country has provided the most inclusive climate change governance systems among developing countries. Furthermore, the country is regarded as one of the most advanced in Africa in terms of research on climate change (Ziergovel et al., 2014).



As the Constitution of the country, the state has three spheres of government: national, provincial, and local (Nhamo & Agyapong, 2019). Every province in the country is given a mandate by the national government to develop a climate change strategy tailored to its unique climatic situation, threats, and impacts (Godsmark, 2019). However, researchers like Montmasson-Clair and Zwane (2016) argue that most provincial institutions are currently at different levels of climate change adaptation, with only Western Cape, Gauteng, Eastern Cape, KwaZulu-Natal, and Limpopo being the provinces that have developed climate change response strategies. Table 1 provides the provincial climate change response strategies in the country.

Provinces with climate change response plan	Provinces with no climate change response plan	Budget allocated	Dedicated institutional arrangements
✓ Western Cape climate change response framework for agricultural sector ✓ Gauteng climate change response strategy ✓ Eastern Cape climate change response strategy ✓ KZN climate adaptation plan ✓ Limpopo Green Economy Plan	✓ Free State ✓ North West ✓ Mpumalanga ✓ Northern Cape	✓ Western Cape (minimal dedicated budget) ✓ KwaZulu-Natal (minimal dedicated budget)	✓ Western Cape ✓ KwaZulu-Natal

Table 1: Provincial climate change response plans in South Africa

Sourc: Montmasson-Clair & Zwane (2016)

Table 1 indicates that nearly half of the country's provinces have not developed a climate change response plan. Additionally, only two provinces have a budget and institutional departments for climate change activities. Most provinces with climate change response plans, including the Eastern Cape, lack the institutional and financial capacity to implement these plans. The Eastern Cape Climate Change Response Strategy (ECCCRS) has an objective that includes multi-sectoral planning for climate change at levels that have yet to be achieved (Santhia, Shackleton, and Pereira, 2018).

Governance and implementation challenges related to climate change within the Eastern Cape Province

The province of the Eastern Cape is led by the Eastern Cape Provincial Department of Economic Development, Environment, and Agriculture (DEDEA), which was established in 2011 (DEDEA, 2011). The ECCCRS aligns with the National State Paper, which serves as a guideline outlining the government's expectations and the actions that all provinces and municipalities should take to achieve the desired outputs (Ziergovet et al., 2014; Montmasson-Clair & Zwane, 2016). Climate change adaptation is becoming increasingly important to the Eastern Cape Province due to its vulnerability to climate change (Ziergovet et al., 2014). Similarly, Santhia, Shackleton, and Pereira (2018) state that it becomes critical for municipalities to adapt to climate change and increase their capacity due to the province's vulnerability to climate change effects. Fortunately, the National sphere of government has provided the Climate Change Let's Respond Toolkit as a reference for local government institutions to integrate climate change risk and opportunities into municipal planning (DEA, 2012).



Challenges	References in the Eastern Cape Province	Other references in South Africa
Mainstreaming of climate change in the municipal IDP is weak	Santhia, Shackleton, and Pereira (2018)	Ziervogel et al. (2014)
Lack of climate change coordination between government institutions	Santhia, Shackleton, and Pereira (2018)	Ziervogel et al. (2014); Montmasson-Clair and Zwane (2016); Averchenkova, Gannon, and Curran (2019); Godsmark et al. (2019)
Climate change is isolated in the environmental department	Santhia, Shackleton, and Pereira (2018)	Ziervogel et al. (2014)

Table 2: Challenges of the implementation of the municipal climate strategy

Source: Gadu, Adom & Simatele (2024)

However, researchers such as Santhia, Shackleton, and Pereira (2018) state that climate change mainstreaming in municipal planning is weak within the Eastern Cape Province. Additionally, there is a general lack of effort to ensure climate change coordination between district and local-level municipalities in the Eastern Cape (Santhia et al., 2018). This is not exclusive to the Eastern Cape, as other parts of the country are still struggling to achieve this objective (Godsmark et al., 2019). The isolation of climate change within the Environmental Department in most municipalities of the province (Santhia et al., 2018). Table 2 demonstrates some of the challenges affecting the implementation of climate change plans within the Eastern Cape Province.

3. RESEARCH DESIGN AND METHODOLOGY

3.1 Study Area

The Eastern Cape is one of South Africa's nine provinces, situated in the southern coastal region (Walz et al., 2020). The province has two metropolitan municipalities and six district municipalities, which are further divided into 29 local municipalities (Santhia et al., 2018). The province is arguably one of the poorest in the country (Santhia et al., 2018), with a high proportion of households dependent on agriculture (Walz et al., 2020), characterised by high levels of poverty and illiteracy (Popoola, Yusuf, & Monde, 2020). All the above-mentioned features are associated with climate change vulnerability (Bernauer & Scaffer, 2010). Hence, the province is regarded as one of the most vulnerable provinces in the country to climate change (Santhia et al., 2018). Moreover, the local government institutions of the province are suffering from limited skills and capacity to adapt to climate change (DEA, 2012).



Figure 3: Study sites in Eastern Cape Province, South Africa

Source: Cartography Unit, University of the Witwatersrand (2022)

3.2 Research Design

The study employed an exploratory research design, which was necessitated by the qualitative research method. Additionally, the study employed a qualitative method to collect data on institutional and capacity challenges related to the quality of water governance and climate change governance.

3.3 Sample Procedures and Sample Size

The data for the study were collected in 2025. The selected institutions within the province included municipalities and water service providers, which are essential to the scope of water governance. A total of 18 research participants from three different water institutions were interviewed in the study. Based on the research questions and objectives, the study employed purposive and snowball sampling methods. The sample size was justified by purposively making a selection of key directorates, institutions and community representatives' whom were are directly affected by water governance and climate change, which ensures that participants possessed the necessary knowledge and experienced which aligns with the study objectives. The data collection continued until the saturation point was reached, at this stage with no new themes that emerged from the participant's which made an indication that the data sample size was sufficient to capture the perspectives of the target population.

3.4 Data Collection Method

The study employed interviews to collect primary data. The study employed semi-structured interviews to uncover institutional capacity challenges in the province. The study also utilized



secondary data to complement the primary data, in the form of government gazettes, reports, and archives. The secondary data were critical and helpful in identifying existing policy frameworks for water governance and climate change adaptation, providing more insights into challenges and barriers to climate change adaptation and water governance at the local government level.

3.5 Data Analysis

The primary data were collected through interviews, which were digitally recorded and subsequently transcribed into text. The study further employed thematic analysis to analyze the qualitative data obtained. Kiger and Varpio (2020) state that Thematic Analysis is a method used for qualitative data analysis, which seeks to identify themes, analyze, and report repeated patterns using an inductive approach. The thematic analysis for the study provided a framework that allowed the transcription of the interviews into themes from the recorded audios.

3.6 Ethical Considerations

The institution granted the researcher's application for an ethical clearance certificate. Informed permission forms were distributed to the various participants, and the nature and scope of the study were described. Crucially, consent papers were distributed to protect participants' privacy and anonymity, and their information was kept private for the duration of the study. Through the Chris Hani District Municipality, the Eastern Cape Department of Water and Sanitation, and the Amatola Water Board, the researcher also filed letters to gatekeepers, which were approved.

4. FINDINGS AND DISCUSSION

Finding 1: Insufficient municipal staff and maintenance problems hinder water service provision

A participant raised the continuous lack of capacity and maintenance of water infrastructure as a serious concern; these issues were highlighted as significant barriers preventing the achievement of desired water outputs within the district. That idea was expressed and echoed by the following participants:

"There is a huge problem within the plant. I am supposed to have 8 General Assistants and 2 operators. Still, currently I have 1 General Assistant and 1 operator working in a plant, which significantly affects plant productivity due to a lack of workforce." (Participant 2)

"Our infrastructure has reached its life expectancy, and still needs to be upgraded." (Participant 5)

From the above comments, the researcher noted that capacity issues plague the water infrastructure, as the workforce is not available, which significantly affects the productivity of water flow and causes delays in duties being carried out. The study found that municipal wastewater treatment plants suffer from a shortage of staff and ageing infrastructure, which directly affects operational capacity, as noted by Participant 2. This aligns with the view of Viljoen and Der Walt (2018) that water problems are linked to poor and outdated infrastructure as well as a shortage of staff. The lack of sufficient human capacity and technical resources reflects governance inefficiencies and reduces the ability of municipalities to adapt and manage climate-related pressures.



The findings regarding ageing infrastructure and a lack of technical capacity within the municipality pose a significant threat to water availability and quality, which elevates the issue of human security. According to the securitisation of water theory, such challenges justify treating water service delivery as a security issue that demands immediate policy attention. The lack of infrastructure upgrades in the wake of climate stress has compromised the water supply's reliability and safety, creating grounds for public health risks and social instability. This creates a need for water governance at the national and local government levels to prioritise security planning. Tshona et al. (2025) note that, despite government mechanisms being in place, infrastructure deficits and backlogs still exist in municipalities, and that inadequate maintenance methods make maintaining water infrastructure difficult. Furthermore, as noted by Tshona et al. (2025), the lack of sufficient staff and funding further strains municipalities, leaving key positions vacant, which ultimately affects service delivery. Similarly, adaptive water governance research highlights the need for flexible and decentralised decision-making structures capable of responding to climate variability, especially in the water context.

Finding 2: Conflicting water licensing priorities challenge governance coordination

The present study, through its various participants, found a good working relationship between the local government and the Department of Water and Sanitation (DWS); however, over the last few years, there have been disagreements between the two entities concerning water licenses and allocation. Some participants had the following to say:

"We have a good relationship with DWS; however, in the last couple of years, I feel like governance has not fully interfered with the issue of water licenses." (Participant 10)

"For example, we had a debate and disagreement with DWS that water must first go to the people before animals, hence we wanted to obtain water licenses alongside the river, but we could not agree on that one." (Participant 11)

From the participants' comments above, the present study notes that although a working relationship exists between the two water entities, disagreements regarding the prioritisation of water allocation and licensing have persisted between the two parties. Although the participants highlighted a good, healthy working relationship between the municipality and the Department of Water and Sanitation (DWS), there have been various disagreements over the issue of licensing priorities, as outlined by Participant 10. This aligns with Antonio et al. (2019), who state that conflicts over land, forest, and water from various stakeholders and groups often impede decision-making processes, ultimately affecting service provision. These conflicts indicate a lack of coherent intergovernmental alignment, which undermines the concept of adaptive governance. Similarly, conflicts over water licensing and resource priorities (Finding 2) reveal tensions between local and national agencies, the municipality, and the DWS. Literature on institutional fragmentation and competing mandates demonstrates that without coordination and consensus-building, allocation decisions lead to a misalignment of priorities (Bartlett & Dedekorkut-Howes, 2023; Yasin, Breadshell & Tahir, 2020). The disagreements between the two entities can be interpreted through the lens of the Negative Consumer Satisfaction Theory. Communities and stakeholders expect water allocation to prioritise human needs, but due to conflicts within government mandates and misaligned institutional priorities provide a performance gap which leads to dissatisfaction of consumers. This finding expands the negative consumer satisfaction theory by highlighting that dissatisfaction is not individual related but can be seen through institutional miscoordination in public service delivery.



Finding 3: The lack of capacity building affects climate change adaptation at municipalities

Capacity training and guidance become integral, especially when dealing with the finances of municipalities. The present study highlights issues related to capacity and training shortfalls regarding climate change adaptation learning. Participants said the following:

"The staff is aware of the dangers of climate change, but there is an awareness problem regarding the financial implications among staff members." (Participant 12)

"Yes, we are aware, but we see climate change mostly on television and have never received any training relating to climate change." (Participant 13)

"We see climate change on social media, and we only know it since it has become a reality within the region; otherwise, we have never received any training or guidance on climate change adaptation or its financial implications." (Participant 14)

From the participants' comments above, it is clear that there is a lack of capacity training and guidance about the financial implications of climate change and adaptation. Although there is public awareness through social media and television, workshops and capacity-building programmes on climate change are still not being done by the municipality. The study found that issues regarding climate change exist among municipal staff, including awareness; however, a significant gap limits their ability to manage its financial and operational implications due to a lack of capacity building regarding climate adaptation education. Birchell and Bonnet (2021) agree that issues such as inadequate capacity building and internal procedures often impede the successful implementation of climate change adaptation. This type of shortfall highlights that inadequate investment in human capital undermines the municipality's climate governance effectiveness, making the local government vulnerable to the effects of climate change.

These findings align with the literature, which stresses that knowledge, awareness, training, and technology are significant enablers of adaptation, especially where governance systems must interpret complex scientific information and allocate resources accordingly (Bartlett & Dedekorkut-Howes, 2023; Yasin, Breadshell & Tahir, 2020). Klein et al. (2023) identify human resource and knowledge barriers as obstacles to the adaptation of water quality. Without developing competencies and adaptive knowledge systems, municipalities risk not implementing climate adaptation strategies (Bartlett & Dedekorkut-Howes, 2023). The study's findings about the lack of capacity within the municipality can be aligned with the negative consumer satisfaction theory. Citizens and internal stakeholders expect that local government institutions to manage climate risks effectively. However issues such as limited capacity can compromise the adaptive measures and stakeholder confidence. This extends the negative consumer satisfaction theory by highlighting that dissatisfaction as an outcome of organisational and human capital limitations rather than unmet consumer expectations

Finding 4: The issue of financial underspending causes delays in critical water projects

The participants highlighted the issue of financial underspending and how it has affected the municipality's economic strength, which has significantly affected water projects. Participants said the following:

"In the past 3 years, we have been fully spending our grant allocations; however, in 2021 and 2022 we suffered and underspending of 49 million, and unfortunately when we applied for a



rollover to National Treasury, and the 49 million was never approved by the National Treasury, which later affected a lot of our water projects.” (Participant 11)

“Yes, that is correct, the underspending of finances led to delayed water projects, and if you have a 49 million rand rejected by the National Treasury, you will end up not fulfilling your mandates.” (Participant 13)

“Due to the 49 million rand rollover being rejected, all projects within the 2021 and 2022 financial year were put on hold due to limited funding available.” (Participant 12)

The participants’ comments above highlight that the issue of underspending of allocated grants has caused significant delays in water projects. Such issues are indicative of inadequate financial governance mechanisms. Although the municipality receives adequate funding from national and provincial structures, participants noted the issue of underspending allocated budgets as a serious concern. Participants 11 and 12 noted that underspending had huge implications and caused delays in essential water projects. This aligns with the Municipal Financial Management Act report (2022/2023), which highlights several municipalities suffering project delays due to cash flow problems and late payments to contractors, significantly delaying water projects, suggesting a breakdown in fiscal planning and execution, and impeding climate-resilient initiatives.

The issue of underspending and delays in water infrastructure projects undermines the ability of the state to prevent and respond to water challenges. The securitisation of water theory posits that once water is framed as a security issue, it must be supported by resources and political commitment. Underspending contradicts this logic, indicating a lack of prioritisation and weakening the state's ability to protect communities from water-related threats. The study's findings indicate that financial underspending causes critical delays in water projects. This aligns with the negative consumer satisfaction theory, which posits that dissatisfaction happens when poor service delivery is provided. When budgets are not entirely spent, this causes essential delays in water projects, directly affecting the water supply. Furthermore, the finding expands the Negative Consumer Satisfaction theory providing a new dimension of public financial management as an enabler of dissatisfaction, emphasising that service delivery is not an outcome only but a government process that shapes consumer perceptions.

Finding 5: Lack of specific climate change funding hinders adaptation efforts by municipalities

The present study also found many municipal grants being given to municipalities; however, participants highlighted the lack of specific conditional climate change grants, as per the following quotes:

“No, currently we do not have any grant for climate change within the municipality.” (Participant 13)

“We only get conditional grants for water and sanitation projects; however, nothing is allocated for climate change specifically.” (Participant 12)

“We have multiple grants, from infrastructure, sanitation, and bulk water grants; however, the municipality allocates no climate change grants.” (Participant 11)



The comments above highlight that although the municipality has multiple grants, there is a lack of conditional grants for climate change. No specific grants are allocated for this phenomenon despite massive financial implications. Although there is general funding for climate change in some instances within the country, the participants noted that no funding was allocated explicitly for climate change adaptation or mitigation, as noted by Participants 11 and 13, respectively. This is further supported by Pieterse and du Toit (2025), who state that local government does not have any funding or budgets allocated for climate change adaptation. Such a financial gap highlights the municipality's inability to provide a structured climate governance strategy. Another finding is the lack of specific funding for climate change adaptation at the local level. According to the negative consumer satisfaction theory, many citizens are displeased when their expectations are not met, especially regarding safety and long-term service issues. This expands the negative consumer satisfaction theory by suggesting that consumer satisfaction is influenced by perceived preparedness and the adaptation of service providers, not by immediate service quality.

5. RECOMMENDATIONS

5.1 Institutional Capacity Building

The study findings indicate that capacity constraints within the municipality impair its ability to manage water governance and climate change. The study recommends that the municipality hold frequent workshops about climate change and its financial implications. This could be achieved by inviting universities to provide quarterly training and workshops to the municipality, so that the staff can become more aware of the dangers of climate change and how they can adapt.

5.2 Community Initiatives

The municipality can improve by introducing specifically community-based organisations dealing with climate change. These community-based organisations can provide critical information and create awareness programmes to educate people about climate change and risk communication. This could benefit subsistence farmers, who were identified in the study as being most at risk from climate change effects, due to their limited education on climate change and risk communication. Such community initiatives can help increase awareness and education within the district.

Moreover, the municipality can establish a climate change adaptation municipal forum, comprising departments such as Engineering and Infrastructure, Budget and Treasury, Disaster Management, and Local Economic Development. This municipal forum would be able to identify explicitly how each directorate is affected by climate change and how each can adapt to such devastating effects.

5.3 Legislative and Policy Initiatives

Each department could do this by advising senior managers to talk with national leaders to push for a review of legislation and suggest the necessary changes. This will also assist in ensuring that there is transparency, accountability, and compliance among water governance stakeholders. Alternatively, in the spirit of good governance, the three water governance stakeholders can sign a memorandum of understanding that will promote accountability mechanisms whenever there is noncompliance among the stakeholders.



5.4 Advanced Digital Analytics

The present study recommends that the municipality use advanced technology systems to provide geographical information about the district and the number of individuals. Alternatively, the municipality can conduct quarterly oversight within the district through its local municipalities to ascertain the population growth numbers. Such initiatives can assist the municipality to become more aware of population changes and plan their maintenance of water systems accordingly. The municipality could even partner with the Department of Home Affairs within the district to obtain assistance regarding population numbers, enabling them to plan better.

6. CONCLUSION AND FURTHER RESEARCH

Water governance has a critical role to play when it comes to providing water within the communities. Although, there are many climate change plans developed by municipalities, the consistent lack of climate change adaptation that is attributed by poor capacity challenges internally within these organisations have impair their vision on achieving their constitutional obligation. The study employed a qualitative research method with the exploratory design used. Furthermore, data collection methods that were used in the study was semi structured interviews with thematic analysis used a method data analysis. The findings of the study reveal internal water governance capacity constraints, poor water governance coordination, lack of capacity building by municipalities, and lack of climate change conditional grants which makes it difficult for these institutions to adapt towards climate change. Furthermore, recommendations from the study reveal community ked initiatives, data and the use of artificial intelligence, institutional capacity building mechanism amongst others.

The study examined the role of water governance quality and institutional capacity in facilitating climate change adaptation. However, further research could be done on monitoring and evaluation institutional capacity at local government institutions and this include the monitoring of financial and human resources. Additionally, more research could be done the role of community engagement when it comes to climate change adaptation and how these community based organisations could provide a critical option on how municipalities can enhance adaptation from a community point of view since communities are part of municipalities.



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Reimagining Innovation Pathways for Sustainability: Applying the Triarchic Theory of Cognitive Disposition (TTCD) Across Research, Practice, and Policy.

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Abstract

The accelerating urgency of sustainable development demands innovation pathways that are not only technologically advanced but also ethically grounded, contextually responsive, and aligned with long-term human and ecological flourishing. This paper advances a conceptual contribution by extending the Triarchic Theory of Cognitive Disposition (TTCD) as a framework for reimagining innovation pathways for sustainability. Originally developed and empirically validated in doctoral research, the TTCD has been further elaborated in peer-reviewed publications and a practitioner-oriented book, demonstrating its relevance across multiple contexts of leadership, strategy, and technological governance. The TTCD comprises three interdependent constructs: Episteme-Analytical Intelligence (rigorous, evidence-based reasoning), Techne-Inventive Intelligence (creative, applied, and design-oriented thinking), and Phronesis-Synergic Intelligence (practical wisdom that integrates ethical, contextual, and relational considerations). When applied to sustainability challenges, this triarchic lens enables leaders and innovators to bridge the fragmentation between research, practice, and policy. Specifically, the model fosters evidence-based sustainability research (SDG 12: Responsible Consumption and Production), nurtures inventive practices in green entrepreneurship and emerging technologies (SDG 9: Industry, Innovation and Infrastructure), and cultivates synergic decision-making for inclusive and equitable development (SDG 10: Reduced Inequalities). By aligning with the African Union's Agenda 2063, the TTCD highlights the importance of Afrocentric innovation pathways that integrate indigenous knowledge systems with global sustainability agendas. The framework also provides guidance for policymakers to craft governance mechanisms that balance technological progress with social justice, and for practitioners to embed sustainability into organisational culture and strategy. This paper contributes conceptually by proposing TTCD as an integrative model for advancing sustainability through balanced cognitive dispositions. It argues that reimagining innovation pathways requires not only new technologies and business models but also new ways of thinking, deliberating, and acting. The TTCD thus offers a holistic, future-oriented framework to guide leaders, researchers, and policymakers in building just, resilient, and regenerative societies.

Keywords: triarchic cognitive disposition, sustainability, innovation pathways, Agenda 2063, SDGs

Introduction

Background

The global discourse on sustainable development has gained unprecedented urgency in the face of accelerating environmental degradation, widening socio-economic inequalities, and the disruptive potential of emerging technologies. Agenda 2030, expressed through the United Nations' Sustainable Development Goals (SDGs), and Africa's Agenda 2063 both highlight the need for innovation



pathways that are not only technologically advanced but also ethically grounded and socially inclusive. Yet, dominant approaches to innovation often privilege either technological efficiency or economic growth, neglecting the cognitive and ethical dispositions required for sustainability-oriented leadership and governance (Floridi et al., 2018; Oosthuizen, Ungerer & Volschenk, 2023).

The Fourth Industrial Revolution (4IR) and its transition towards a possible Fifth Industrial Revolution (5IR) have amplified the complexity leaders face. Artificial intelligence, biotechnology, and green technologies provide opportunities for sustainable development, but they also carry risks of reinforcing inequality, undermining social trust, and producing unintended ecological consequences (Brynjolfsson & McAfee, 2014; Schwab, 2016). Within this context, the Triarchic Theory of Cognitive Disposition (TTCD) was developed and empirically validated to provide a leadership and management framework that balances analytical reasoning, inventive creativity, and practical wisdom (Oosthuizen, 2022; Oosthuizen et al., 2024). The TTCD has since been further elaborated in scholarly articles (Oosthuizen, 2024; Oosthuizen, Ungerer & Volschenk, 2024) and in a practitioner-oriented book (Oosthuizen, 2024b), showing its applicability across leadership, technological governance, and innovation management.

The TTCD's three domains—Episteme-Analytical Intelligence, Techne-Inventive Intelligence, and Phronesis-Synergic Intelligence—offer a holistic cognitive lens that enables leaders to reimagine innovation pathways for sustainability. By bridging the domains of research (knowledge creation), practice (entrepreneurial and technological application), and policy (governance and regulation), the TTCD aligns leadership thinking with the imperatives of long-term human and ecological flourishing (Oosthuizen, 2024a).

Problem Statement

Despite global efforts, innovation for sustainability remains fragmented. Research is often disconnected from practical application, policy frameworks lag behind technological change, and many innovation pathways are driven by narrow economic imperatives rather than inclusive human development (Bag et al., 2021). In Africa, the challenge is compounded by historical inequities, weak governance structures, and limited integration of indigenous knowledge systems into formal innovation strategies (Agenda 2063, African Union, 2015).

Existing leadership and innovation models fall short of providing the integrative perspective required to navigate these complexities. Traditional paradigms either overemphasise rational-analytical capacity or focus narrowly on entrepreneurial inventiveness, neglecting the role of phronesis (practical wisdom) in guiding responsible choices (Aristotle, ca. 350 BCE/1925; Oosthuizen, 2024b). The result is a sustainability gap: while technological solutions proliferate, their ethical grounding, contextual responsiveness, and long-term societal implications remain inadequately addressed.

This paper argues that the missing link lies in cultivating a balanced cognitive disposition in leaders, innovators, and policymakers. The TTCD provides such a framework by integrating analytical rigour, inventive foresight, and synergic wisdom, thus enabling more coherent, ethically-informed, and contextually responsive innovation pathways for sustainability.



The overarching objective of this paper is to conceptually advance the Triarchic Theory of Cognitive Disposition as a framework for reimagining innovation pathways for sustainability, with explicit alignment to the SDGs and Africa's Agenda 2063. The specific objectives are to:

1. Situate TTCD within the sustainability discourse by linking its three cognitive domains to global and continental frameworks such as SDG 9 (Industry, Innovation, and Infrastructure), SDG 10 (Reduced Inequalities), SDG 12 (Responsible Consumption and Production), and Agenda 2063 aspirations.
 2. Demonstrate the integrative potential of TTCD in bridging the current fragmentation between sustainability research, entrepreneurial practice, and policy formulation.
 3. Propose TTCD as a leadership and governance model that balances technological advancement with ethical responsibility, social inclusion, and ecological stewardship.
 4. Contribute a conceptual pathway for scholars, policymakers, and practitioners to adopt TTCD as a cognitive framework guiding innovation for just, resilient, and regenerative societies
- [Literature Review](#)

The literature review lays the conceptual foundation for this study by situating the Triarchic Theory of Cognitive Disposition (TTCD) within the broader sustainability and innovation discourse. It begins by examining how innovation and sustainability are framed in global and continental agendas, particularly the UN Sustainable Development Goals (SDGs) and Africa's Agenda 2063. The review then turns to the leadership challenge in complex futures, highlighting the role of cognitive dispositions as a critical yet underexplored dimension. From there, it introduces the TTCD framework as an empirically validated model that integrates analytical, inventive, and synergic intelligences. The discussion proceeds to illustrate how TTCD illuminates innovation pathways for sustainability across research, practice, and policy, before concluding with a call for a phronetic turn in innovation theory—one that emphasises practical wisdom, ethical responsibility, and inclusive decision-making as central to reimagining sustainable futures.

[Innovation, Sustainability, and Global Agendas](#)

Innovation has long been recognised as a central driver of economic development and competitiveness (Schumpeter, 1934). However, the contemporary sustainability discourse challenges traditional innovation paradigms by emphasising not only efficiency and growth, but also equity, ecological stewardship, and intergenerational responsibility. The United Nations' Sustainable Development Goals (SDGs) provide a global blueprint for balancing these imperatives, particularly through SDG 9 (Industry, Innovation, and Infrastructure), SDG 10 (Reduced Inequalities), and SDG 12 (Responsible Consumption and Production). These goals highlight the critical need for innovation that is socially inclusive, environmentally sustainable, and grounded in evidence-based policy (UN, 2015).

Within the African context, the African Union's Agenda 2063 further emphasises the importance of innovation pathways that are Afrocentric, context-sensitive, and inclusive of indigenous knowledge systems. Aspirations such as "A prosperous Africa based on inclusive growth and sustainable development" and "An Africa of good governance, democracy, respect for human rights, justice and the rule of law" call for leadership and innovation models that integrate global advances with local



realities (African Union, 2015). The challenge, therefore, lies in cultivating a leadership cognitive disposition that can navigate the complexity of global sustainability frameworks while remaining contextually relevant to Africa's socio-political and economic landscape.

Leadership and Cognitive Disposition for Complex Futures

Leadership in times of technological disruption and socio-ecological crisis requires more than technical expertise; it requires cognitive flexibility, ethical grounding, and collaborative capacity (Hughes et al., 2018; Floridi et al., 2018). Traditional leadership theories—traits, behaviours, contingency, and transformational leadership—have contributed valuable insights but fall short in addressing the multidimensional challenges posed by the Fourth and Fifth Industrial Revolutions (Oosthuizen, 2024b).

The concept of cognitive disposition has thus emerged as a critical construct for understanding leadership effectiveness in complex and uncertain contexts. Cognitive dispositions are not mere habits of thought, but enduring mental attitudes and abilities that shape how leaders perceive, interpret, and respond to complexity (Ritchhart, 2001; De Houwer et al., 2017). Oosthuizen's doctoral research and subsequent elaborations developed the Triarchic Theory of Cognitive Disposition (TTCD) as an empirically validated framework to capture these essential dispositions for contemporary leadership (Oosthuizen, 2022; Oosthuizen et al., 2024).

The Triarchic Theory of Cognitive Disposition (TTCD)

The TTCD integrates Aristotle's intellectual virtues—episteme (theoretical knowledge), techne (practical expertise), and phronesis (practical wisdom)—with Sternberg's triarchic theory of intelligence, yielding a holistic model for leadership in disruptive times (Aristotle, ca. 350 BCE/1925; Sternberg, 1985).

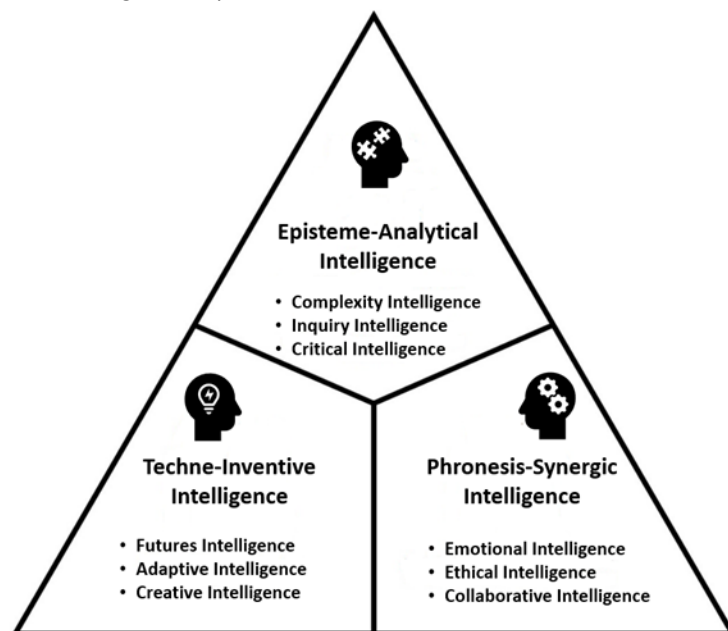


Figure 4: Triarchic Theoretical Framework of Cognitive Disposition



The framework comprises three interdependent domains:

- **Episteme-Analytical Intelligence:** Anchored in complexity, inquiry, and critical intelligences, this domain emphasises evidence-based reasoning, analytical depth, and the ability to interrogate assumptions. It provides leaders with the cognitive capacity to conduct sustainability-oriented research and make informed decisions amidst uncertainty (Oosthuizen, 2024b).
- **Techne-Inventive Intelligence:** Encompassing futures, adaptive, and creative intelligences, this domain fosters innovation, foresight, and resilience. It equips leaders and entrepreneurs to envision sustainable futures, develop green technologies, and craft innovative business models aligned with SDGs and Agenda 2063 aspirations (Oosthuizen, Ungerer & Volschenk, 2023).
- **Phronesis-Synergic Intelligence:** Comprising emotional, ethical, and collaborative intelligences, this domain integrates moral reasoning, relational capacity, and inclusivity. It guides decision-making toward justice, equity, and ecological balance, ensuring that innovation serves not only economic but also societal and environmental flourishing (Oosthuizen, 2024a).

By integrating these domains, TTCD offers a balanced “intelligence configuration” for navigating sustainability challenges. Its empirical validation through structural equation modelling strengthens its theoretical robustness, while its application across contexts demonstrates practical utility (Oosthuizen, 2022; Oosthuizen et al., 2024).

Innovation Pathways through the TTCD Lens

Innovation for sustainability requires more than isolated technological solutions; it demands pathways that integrate research, practice, and policy into a coherent whole (Chen et al., 2018). Fragmentation often arises when research remains abstract, practice pursues short-term gain, and policy lags behind technological advancement. The TTCD directly addresses this gap:

- **In research**, Episteme-Analytical Intelligence fosters rigorous inquiry into sustainable technologies, consumption patterns, and ecological systems (SDG 12).
- **In practice**, Techne-Inventive Intelligence nurtures entrepreneurship, adaptive strategies, and creative applications of emerging technologies to green industries and infrastructure (SDG 9).
- **In policy**, Phronesis-Synergic Intelligence supports inclusive governance, ethical AI adoption, and frameworks that reduce inequalities while promoting ecological stewardship (SDG 10; Agenda 2063).

This triarchic alignment situates TTCD as a bridging framework (Table 1) between global sustainability frameworks and contextual realities, especially within African innovation ecosystems.

Table1: TTCD as a bridging framework

TTCD Domain	Innovation Dimension	Relevant SDGs	Agenda 2063 Aspirations
Episteme-Analytical Intelligence	Research – rigorous inquiry, evidence-based sustainability analysis	SDG 12: Responsible Consumption & Production	A prosperous Africa based on inclusive growth & sustainable development



Techno-Inventive Intelligence	Practice – entrepreneurial application, green innovation, adaptive strategies	SDG 9: Industry, Innovation & Infrastructure	Africa as an innovation-driven economy & hub for green industrialisation
Phronesis-Synergic Intelligence	Policy – governance, ethics, inclusive decision-making	SDG 10: Reduced Inequalities	An Africa of good governance, democracy, respect for human rights, justice & equity

Towards a Phronetic Turn in Innovation Theory

Recent scholarship on responsible research and innovation (RRI) stresses the need for anticipatory, reflexive, inclusive, and responsive approaches to innovation (Stilgoe et al., 2013). Similarly, African thought traditions emphasise Ubuntu and communal well-being, offering valuable resources for cultivating innovation that is contextually rooted and socially just. The TTCD resonates strongly with this phronetic turn, where practical wisdom (phronēsis) becomes central to guiding innovation not merely as a technical process but as an ethical and relational practice (Oosthuizen, 2024b).

Thus, the TTCD provides an integrative conceptual foundation for reimagining innovation pathways for sustainability: analytically rigorous, creatively inventive, and ethically synergic. Its alignment with SDGs and Agenda 2063 highlights both global relevance and Afrocentric grounding, offering a unique contribution to the literature on innovation, leadership, and sustainability.

Research Design and Methodology

To advance the Triarchic Theory of Cognitive Disposition (TTCD) into the domain of sustainability innovation, this study employs a conceptual, theory-building design rather than an empirical case study. The methodological focus is on developing new theoretical linkages by synthesising diverse literatures across sustainability, leadership cognition, and governance. Guided by the principles of an integrative review (Snyder, 2019), the approach combines systematic literature mapping with citation tracing and conceptual coding. This design enables both breadth and depth: capturing foundational works through backward reference tracing, identifying emerging debates through forward citation tracing, and grouping insights into higher-order themes aligned with the TTCD framework. The methodology thus provides a transparent, rigorous pathway for extending TTCD as a framework for reimagining innovation pathways that align with the SDGs and Agenda 2063.

Research Paradigm and Design

This paper adopts a theory-building conceptual essay design. Rather than reporting new empirical findings, it advances and extends the Triarchic Theory of Cognitive Disposition (TTCD) as a framework for reimagining innovation pathways for sustainability. Conceptual research is particularly appropriate when existing empirical models are insufficient to capture complex, multidisciplinary challenges such as the integration of innovation, sustainability, and governance (Snyder, 2019). The design is guided by three principles:

1. **Integrative synthesis** – drawing from a wide body of literature at the intersection of sustainability innovation, leadership cognition, and governance frameworks.



2. **Theoretical elaboration** – extending the TTCD, originally validated in leadership and technological contexts (Oosthuizen, 2022; Oosthuizen et al., 2024), into the sustainability discourse.
3. **Normative alignment** – situating the framework explicitly within the normative imperatives of the SDGs and Agenda 2063, ensuring global and Afrocentric relevance.

Methodological Approach

The methodology follows an integrative review strategy, which is particularly suitable when the aim is to synthesise conceptual, normative, and empirical works in order to advance new theoretical linkages (Snyder, 2019). Unlike systematic reviews that prioritise aggregation and replicability, the integrative approach allows for interpretive, critical, and cross-disciplinary synthesis—an approach necessary for addressing the multifaceted relationship between cognitive disposition, innovation, and sustainability. In line with this flexibility, the literature search was not limited to keyword-based database queries but also employed citation tracing to ensure comprehensiveness. This involved two complementary steps:

1. **Backward tracing (reference chasing):** Examining the bibliographies of core texts in order to identify earlier foundational contributions on sustainability innovation, cognitive dispositions, and governance frameworks.
2. **Forward tracing (citation chasing):** Using citation databases (e.g., Scopus, Google Scholar) to locate subsequent works that cited these core texts, thereby capturing more recent developments, applications, and critiques.

By combining backward and forward tracing, the review surfaced both historical foundations and emergent debates, ensuring that the resulting conceptual synthesis was temporally balanced and inclusive.

The final pool of literature was coded for focal constructs, theoretical lenses, and methodological approaches. From this coding, three persistent clusters were confirmed—analytical, inventive, and synergic—which align with the higher-order domains of the Triarchic Theory of Cognitive Disposition (Oosthuizen, 2022; Oosthuizen, Ungerer & Volschenk, 2023; Oosthuizen, 2024). Following the inductive approach outlined by Gioia, Corley, and Hamilton (2013), first-order concepts were grouped into second-order themes and then aggregated into the triarchic domains. This process enabled the extension of TTCD into the sustainability context, positioning it as a cognitive framework for reimagining innovation pathways aligned with the SDGs and Agenda 2063.

Empirical Anchoring

Although this paper does not present new empirical data, it builds on prior empirical validation of the TTCD. Oosthuizen's (2022) doctoral research used a Delphi study and Partial Least Squares Structural Equation Modelling (PLS-SEM) to confirm the reliability and validity of the TTCD framework, structuring nine intelligences into three higher-order constructs. Subsequent peer-



reviewed publications have applied TTCD in contexts of leadership development, innovation governance, and AI stewardship (Oosthuizen, 2024; Oosthuizen et al., 2024).

In this study, these earlier empirical findings are not re-analysed but serve as secondary anchoring evidence. By leveraging this validated framework, this conceptual essay illustrates TTCD's plausibility and transferability when applied to sustainability pathways.

Contribution of the Methodology

This methodological pathway provides (1) conceptual coherence by integrating diverse literatures into a unified explanatory model; (2) theoretical extension by positioning TTCD within sustainability innovation frameworks; and (3) practical relevance by aligning the framework with SDGs and Agenda 2063, thus offering guidance for scholars, practitioners, and policymakers.

The methodological contribution lies in proposing TTCD not as a prescriptive tool but as a conceptual lens to rethink how cognitive dispositions shape innovation for sustainability.

Results and Findings

The integrative review and conceptual synthesis revealed that the **Triarchic Theory of Cognitive Disposition (TTCD)** can serve as a powerful lens to reimagine innovation pathways for sustainability. By aligning the three TTCD domains with the dimensions of sustainability innovation—research, practice, and policy—it becomes evident that balanced cognitive dispositions are essential for achieving the normative aspirations of the SDGs and Agenda 2063.

The analysis showed that:

- **Episteme-Analytical Intelligence** is particularly relevant for sustainability research, ensuring that innovation strategies are grounded in rigorous inquiry, evidence-based policy, and critical evaluation of unintended consequences (Oosthuizen, 2024b).
- **Techne-Inventive Intelligence** emerged as a driver of entrepreneurial action, adaptive innovation, and creative problem-solving in contexts of green industrialisation, renewable energy, and circular economy practices (Oosthuizen, Ungerer & Volschenk, 2023).
- **Phronesis-Synergic Intelligence** was found to be indispensable for embedding innovation within inclusive governance frameworks, ensuring that sustainability pathways reflect ethical responsibility, equity, and Afrocentric perspectives rooted in community well-being (Oosthuizen, 2024a).

A central finding is that TTCD provides a structured mapping to both global and continental sustainability frameworks. Specifically:

- **Episteme-Analytical Intelligence** directly supports **SDG 12 (Responsible Consumption and Production)** by equipping leaders and researchers to assess ecological footprints and consumption patterns with analytical depth.
- **Techne-Inventive Intelligence** resonates with **SDG 9 (Industry, Innovation and Infrastructure)** and Agenda 2063's call for an innovation-driven economy, by cultivating foresight, adaptability, and creative entrepreneurial responses to sustainability challenges.
- **Phronesis-Synergic Intelligence** aligns with **SDG 10 (Reduced Inequalities)** and Agenda 2063's aspirations for justice, governance, and human dignity, by embedding ethical reflection, empathy, and collaboration into innovation pathways.



This triarchic mapping demonstrates how TTCD acts as a **cognitive bridge** between normative frameworks and practical sustainability action.

Another key finding is that TTCD mitigates the persistent fragmentation between sustainability research, practice, and policy. Historically, sustainability research has often been abstract and disconnected from application, while practice has pursued market-driven short-term gains, and policy frameworks have lagged behind technological advancements (Bag et al., 2021).

The TTCD addresses this fragmentation by: (1) providing **researchers** with analytical tools for systemic inquiry; (2) enabling **practitioners** to design adaptive and innovative business models that embrace ecological and social objectives; and (3) guiding **policymakers** to institutionalise ethical and inclusive decision-making processes.

Thus, TTCD does not replace existing sustainability frameworks but offers an **integrative mental model** for aligning them.

Finally, the synthesis revealed a strong resonance between TTCD and the broader call for a **phronetic turn** in innovation leadership. By positioning *phronēsis* (practical wisdom) alongside *episteme* and *techne*, TTCD highlights that innovation is not only a matter of knowledge and invention but also of judgment, ethics, and relational responsibility (Oosthuizen, 2024b). This finding positions TTCD as a normative and cognitive framework for cultivating “**practically wise pathfinders**”—leaders capable of navigating complexity, balancing competing demands, and charting innovation pathways that advance human and ecological flourishing.

Discussion

The findings underscore that sustainable innovation cannot be understood solely as a technological or economic endeavour but as a cognitive and ethical challenge. By situating the Triarchic Theory of Cognitive Disposition (TTCD) within the sustainability discourse, this paper demonstrates that the future of innovation is contingent on how leaders, policymakers, and researchers think, deliberate, and act. TTCD offers a language for bridging the often siloed domains of research, practice, and policy, suggesting that sustainability pathways must be cognitively balanced rather than technologically deterministic.

Existing leadership theories—whether transformational, authentic, or responsible leadership—provide important normative guidance but often lack the cognitive architecture necessary to navigate disruptive, uncertain futures (Oosthuizen, 2024b). TTCD fills this gap by operationalising leadership as a matter of cultivated dispositions across episteme, techne, and phronesis. This positions leaders not just as decision-makers, but as practically wise pathfinders who integrate evidence, invention, and ethics in pursuit of long-term flourishing.

By aligning TTCD with the African Union’s Agenda 2063, the model also contributes to an Afrocentric reframing of innovation theory. Indigenous knowledge systems and Ubuntu-informed ethics provide fertile ground for synergic intelligence that privileges community, justice, and relational accountability. This stands in contrast to Western models of innovation that often prioritise individual entrepreneurship or technological efficiency. TTCD thus offers a platform for African leadership to influence the global sustainability debate with contextually grounded wisdom and inclusive values (Oosthuizen, Ungerer & Volschenk, 2023).

A recurring critique of sustainability frameworks such as the SDGs is their implementation gap—strong normative aspirations but weak practical uptake. TTCD addresses this by equipping leaders with dispositions that directly enable the translation of principles into practice: Episteme-Analytical Intelligence ensures rigour in sustainability research and monitoring. Techne-Inventive Intelligence



drives entrepreneurial and adaptive practices for green innovation. Phronesis-Synergic Intelligence embeds inclusivity, ethics, and justice into governance mechanisms. Thus, TTCD provides a cognitive bridge between normative ideals and operational realities.

Finally, the discussion highlights the need for a phronetic turn in innovation leadership. As Aristotle suggested, neither knowledge (episteme) nor technical expertise (techne) is sufficient without practical wisdom (phronēsis). In the sustainability context, this means that leaders must not only know what is possible and how to achieve it, but also deliberate on whether it is right, just, and beneficial for present and future generations. TTCD embeds this phronetic disposition at the heart of innovation pathways, making it a normative as well as practical framework for sustainability.

Managerial Implications

A central implication for managers and executives is the need to intentionally cultivate a triarchic cognitive disposition. Organisations often overemphasise analytical reasoning or inventive creativity, while neglecting synergic wisdom. This imbalance can lead to technically efficient but socially harmful innovations, or ethically sound policies that lack practical feasibility. By developing all three domains of TTCD, leaders can ensure that sustainability strategies are not only rigorous and innovative but also ethically grounded and contextually responsive.

Managers play a pivotal role in embedding sustainability principles into the DNA of organisational culture. Episteme-Analytical Intelligence equips leaders to base decisions on data-driven environmental and social impact assessments. Techne-Inventive Intelligence helps managers foster a culture of experimentation, resilience, and green entrepreneurship. Phronesis-Synergic Intelligence ensures that sustainability becomes a collective responsibility, grounded in values of fairness, inclusivity, and community engagement.

This integrated approach positions sustainability not as a compliance requirement but as a strategic advantage.

Sustainability challenges are marked by uncertainty and volatility. Managers must therefore cultivate futures-oriented strategic foresight (Techne-Inventive) combined with critical systems thinking (Episteme-Analytical). Together, these dispositions allow executives to anticipate disruptive changes, develop resilient strategies, and avoid short-term decision traps. Crucially, phronetic judgment enables leaders to prioritise long-term societal well-being over narrow profit imperatives, aligning strategy with both SDGs and Agenda 2063 aspirations.

For policymakers and senior managers, the TTCD framework offers practical guidance for governance alignment:

- Analytical capacity to evaluate evidence for sustainability policy effectiveness.
- Inventive capacity to translate policies into adaptive, innovative programmes and incentives.
- Synergic capacity to ensure inclusive stakeholder engagement, especially integrating indigenous knowledge systems and community voices in African contexts.

This triarchic approach equips managers and policymakers to close the implementation gap between normative frameworks (e.g., SDGs, Agenda 2063) and real-world outcomes.

Finally, TTCD highlights the need to cultivate leaders as “practically wise pathfinders” rather than merely technical experts or charismatic visionaries. This requires leadership development programmes that go beyond competencies to foster intellectual character—dispositions of judgment,



discernment, creativity, and ethical responsibility. Business schools, executive education, and organisational leadership pipelines should integrate TTCD-informed training to prepare leaders who can navigate the complexity of sustainability transitions.

Conclusions and Future Research

This paper has advanced a conceptual contribution by extending the Triarchic Theory of Cognitive Disposition (TTCD) into the domain of sustainability-oriented innovation. The integrative review and theoretical synthesis demonstrated that TTCD provides a balanced cognitive framework for reimagining innovation pathways in ways that are analytically rigorous, creatively inventive, and ethically synergic.

Key conclusions include:

- **TTCD as an integrative lens:** The framework addresses fragmentation between research, practice, and policy by offering a triarchic balance across analytical, inventive, and synergic intelligences.
- **Alignment with sustainability agendas:** Each domain of TTCD maps directly onto critical SDGs and Agenda 2063 aspirations, underscoring its global and Afrocentric relevance.
- **Leadership and governance transformation:** TTCD reframes leadership as a matter of cognitive dispositions, positioning leaders as practically wise pathfinders who balance knowledge, invention, and wisdom in pursuit of long-term flourishing.
- **The phronetic turn:** By foregrounding phronēsis (practical wisdom), TTCD responds to calls for innovation pathways that are not only technologically advanced but also ethically responsible and socially inclusive.

In sum, TTCD offers both scholars and practitioners a holistic, future-oriented framework for guiding sustainability transitions. It demonstrates that innovation for sustainability is not merely about new technologies and markets, but about new ways of thinking, deliberating, and acting.

While this paper makes a conceptual contribution, it also opens several avenues for future research:

- **Empirical Application of TTCD in Sustainability Contexts:** Future studies could empirically test TTCD within organisations pursuing green transformation, circular economy practices, or social innovation, using the Triarchic Cognitive Disposition Inventory (TCDI) as a diagnostic tool (Oosthuizen, 2022).
- **Comparative Cross-Cultural Studies:** Research could examine how TTCD manifests across cultural contexts, particularly contrasting African Afrocentric perspectives with Western innovation paradigms. Such studies would deepen understanding of how indigenous knowledge systems and Ubuntu ethics enrich the Phronesis-Synergic domain.
- **Policy-Oriented Research:** Scholars could explore how TTCD-informed frameworks can guide the design and evaluation of sustainability policies, especially in African Union member states implementing Agenda 2063 initiatives.
- **Longitudinal Leadership Development Studies:** Long-term studies could assess the impact of embedding TTCD into leadership development curricula in business schools and executive



education, measuring its influence on decision-making, innovation outcomes, and organisational sustainability.

- **Integration with Responsible AI and Emerging Technologies:** Given the growing role of AI and digital technologies in sustainability transitions, future research could explore how TTCD helps leaders navigate the ethical dilemmas of responsible technology adoption. This would extend the theory's relevance to governance of innovation ecosystems in the digital age.

The accelerating urgency of sustainable development demands not only new technologies but also new mindsets. TTCD provides a roadmap for cultivating such mindsets—anchored in evidence, driven by creativity, and guided by wisdom. By aligning with both the SDGs and Agenda 2063, it positions African and global leaders alike to chart innovation pathways that are just, resilient, and regenerative.

Ultimately, the future of sustainability will be shaped less by the technologies we invent than by the cognitive dispositions of the leaders who guide their adoption and governance.



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AI Declaration

The author acknowledges the use of artificial intelligence (AI) tools (OpenAI's ChatGPT, GPT-5) in the preparation of this manuscript. AI assistance was limited to supporting tasks such as the drafting of outlines, refining language, and generating preliminary summaries of uploaded scholarly works. All conceptual development, critical analysis, integration of sources, interpretation of findings, and final manuscript decisions were conducted by the author. The author takes full responsibility for the originality, accuracy, and integrity of the content presented in this paper.



The Role of Liquefied Natural Gas in Sustainable Logistics, Maritime Decarbonization, and Africa's Emerging Potential.

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Abstract

The maritime and logistics sectors face mounting decarbonization pressures, positioning Liquefied Natural Gas (LNG) as a crucial transitional fuel given its superior environmental performance compared to conventional marine fuels. This study investigates LNG's multifaceted role in sustainable maritime logistics, with particular emphasis on infrastructure development, vessel adoption trends, and Africa's expanding presence in the global LNG landscape. Drawing upon industry reports and peer-reviewed academic literature, the analysis evaluates current patterns in LNG bunkering infrastructure, Floating LNG deployment strategies, and Africa's export capacity, while incorporating critical perspectives from South Africa's heavy-duty vehicle sector and emerging global maritime decarbonization frameworks. The research reveals significant shortcomings in both infrastructure investment and policy formulation across key African markets, notably Mozambique, Nigeria, Congo and South Africa. While LNG demonstrates clear potential for immediate emissions reductions, the findings underscore that achieving long-term sustainability objectives will necessitate the progressive integration of bio-LNG and hydrogen-based alternatives. Furthermore, the study highlights how Africa's substantial LNG potential remains substantially untapped due to persistent infrastructure limitations, prompting the development of targeted policy recommendations designed to accelerate the continent's effective participation in global decarbonization initiatives through LNG adoption. The analysis is theoretically grounded in the Multi-Level Perspective on sustainability transitions and the Technological Innovation Systems framework, which together illuminate the complex dynamics shaping LNG development across African contexts and inform the policy recommendations advanced herein.

Keywords: LNG, maritime decarbonization, Africa, FLNG, sustainable logistics, heavy-duty vehicles, South Africa, Multi-Level Perspective, Technological Innovation Systems



1. Introduction

1.1 Background and Context

Global maritime industry contributes 80-90 percent of international trade (Balcombe et al., 2019), to the global economy. The sector currently stands at a critical juncture in its decarbonization journey, with the International Maritime Organization setting ambitious targets to reduce shipping emissions by fifty percent by 2050 relative to 2008 levels (IMO, 2023). This commitment comes amid growing pressure from international climate agreements, including the Paris Accord, and increasing scrutiny from environmental organizations demanding stricter regulations on marine pollution. The shipping sector, which accounts for nearly three percent of global CO₂ emissions, has traditionally relied on heavy fuel oil, a carbon-intensive fuel that also emits harmful sulfur oxides and nitrogen oxides (Islam Rony et al., 2023; Robalo-Cabrera et al., 2025). In response, the IMO's 2020 sulfur cap regulation mandated a reduction in sulfur content from three and one-half percent to one-half percent, accelerating the search for cleaner alternatives.

Efforts to decarbonize the maritime sector are multifaceted, focusing on transitioning to cleaner fuels and improving energy efficiency. Liquefied Natural Gas has emerged as a viable transitional fuel, offering up to twenty-five percent lower CO₂ emissions compared to heavy fuel oil (Balcombe et al., 2019). However, challenges such as methane slip, a phenomenon where unburned methane escapes during combustion, remains a critical issue, as methane has a global warming potential twenty-eight to thirty-six times higher than CO₂ over a one-hundred-year period (Balcombe et al., 2019; Baresic & Rehmatulla, 2024; Díaz-Cuenca et al., 2025; Pavlenko et al., 2020). Biofuels and hydrogen-based solutions are also being explored as long-term alternatives, though their widespread adoption is hindered by high costs and the need for advanced infrastructure (Al-Yafei et al., 2021).

LNG's advantages extend beyond emissions reductions (Díaz-Cuenca et al., 2025; Pavlenko et al., 2020; Tlalang, 2024; Wang et al., 2025). Compared to conventional marine fuels, LNG combustion produces significantly lower particulate matter and virtually no Sulphur oxide, addressing both air quality and public health concerns in port cities. Additionally, LNG-powered engines operate more quietly, reducing underwater noise pollution that disrupts marine ecosystems (Wang et al., 2025). Technological advancements in engine design and methane capture systems are progressively mitigating methane slip, reinforcing LNG's role as a bridge fuel toward zero-emission alternatives like green ammonia and hydrogen.

Beyond maritime applications, parallel developments in South Africa's heavy-duty vehicle sector demonstrate LNG's viability in land-based freight transport. A recent field study by Tlalang (2024) of one hundred fifty LNG trucks operating on the N3 corridor found fifteen to twenty percent lower CO₂ emissions compared to diesel equivalents, along with fifty percent reductions in particulate matter, making them particularly suitable for long-haul logistics and urban delivery networks. South Africa's N3 highway corridor, a critical freight route between Durban and Johannesburg, has seen pilot deployments of LNG trucks by companies like Volvo Trucks and Renergen,



showcasing the fuel's economic and environmental benefits. These trucks also report cost savings of R3.03 per kilometer, with a payback period of one to three years, making LNG an attractive investment for fleet operators (Tlalang, 2024). However, infrastructure limitations such as the scarcity of refueling stations remain a barrier to widespread adoption, highlighting the need for coordinated public-private investments in LNG supply chains.

1.2 Global LNG Market Overview

The 2024 International Group of LNG Importers (GIIGNL) annual report underscored the continued expansion of the global LNG market, with trade volumes growing by two percent year-on-year to reach 401 million tonnes (GIIGNL, 2024). Casagrande & Dallago (2025) point out that between 2013 and 2023 the expansion of Global LNG market had expanded by 68 percent. This growth is currently driven by rising demand in Asia, particularly China and India, and Europe's push to replace Russian pipeline gas following geopolitical disruptions (Baresic & Rehmatulla, 2024; Pye et al., 2025). Africa, while still a relatively small player, contributed 40.3 million tonnes to global LNG exports in 2023, with major producers like Nigeria, Algeria, and Mozambique leading the charge (IGU, 2024). Nigeria, Africa's largest LNG exporter, shipped 13.0 million tonnes in 2023, though this represented a 1.5 million tonne decline from the previous year due to feedstock shortages and upstream disruptions (GIIGNL, 2024). Meanwhile, Mozambique's Coral Sul Floating LNG project, which came online in 2022, added 2.6 million tonnes to the continent's export capacity, with further expansions planned pending security improvements in the Cabo Delgado region (IMF, 2023).

Despite this progress, Africa's LNG potential remains underexploited, constrained by infrastructure deficits, regulatory hurdles, financing gaps. The continent holds over 210.8 trillion cubic feet of proven gas reserves, yet only a fraction has been monetized due to underdeveloped liquefaction plants, port bottlenecks, and inadequate bunkering facilities (BP, 2023). For instance, South Africa despite having emerging HDV LNG applications lacks a single LNG import terminal, forcing industries to rely on expensive small-scale solutions. Similarly, Nigeria's Lekki Deep Seaport, though equipped with LNG bunkering capabilities, faces delays in operationalizing full-scale services (Osuji & Agbakwuru, 2024). These challenges are compounded by policy inconsistencies, such as taxation uncertainties in South Africa's HDV sector (Tlalang, 2024) and security risks in Mozambique's gas-rich north (IMF, 2023).

1.3 Problem Statement

Despite the recognized potential of LNG to serve as a transitional fuel in the global decarbonization pathway, significant gaps persist in both academic understanding and practical implementation, particularly within the African context. While substantial research has examined LNG adoption in European and Asian markets, the specific barriers, opportunities, and dynamics shaping Africa's LNG landscape remain inadequately theorized and empirically underdeveloped. The continent possesses vast natural gas reserves, yet its participation in the global LNG transition is hindered by complex interactions between infrastructure deficits, policy fragmentation, security challenges, and financing constraints that existing analytical frameworks have failed to systematically address.



Furthermore, the socio-technical dynamics of how LNG transitions emerge, stabilize, or falter in developing economic contexts remain poorly understood. The Norwegian experience, while instructive, cannot be directly transposed to African settings characterized by different institutional configurations, market structures, and governance capacities (Baresic & Rehmatulla, 2024). This study addresses these gaps by applying established sustainability transitions frameworks to analyze Africa's LNG potential, thereby contributing both theoretical insights and practical policy guidance.

1.4 Research Objectives

This paper examines LNG's role in sustainable logistics and maritime decarbonization, focusing on Africa's untapped potential through a theoretically informed mixed-methods approach. It seeks to:

1. Quantify LNG's emissions reductions compared to conventional fuels, accounting for methane slip and lifecycle impacts, while assessing cost-benefit trade-offs using case studies like South Africa's LNG trucks and Mozambique's FLNG projects.
2. Identify key barriers to Africa's LNG adoption, including infrastructure gaps, policy inconsistencies, and financing shortfalls, exacerbated by regional risks like Mozambique's security challenges.
3. Apply the Multi-Level Perspective (MLP) and Technological Innovation Systems (TIS) frameworks to systematically analyze the dynamics shaping LNG development across African markets, thereby providing a robust theoretical foundation for understanding transition pathways.
4. Model pathways for LNG to serve as a bridge to bio-LNG and hydrogen, leveraging Africa's bio-waste resources and pilot hydrogen projects.
5. Propose targeted policy solutions such as standardized bunkering regulations, fiscal incentives, and public-private partnerships to accelerate LNG deployment, aligning with global frameworks like IMO regulations and AfCFTA energy cooperation.

2. Theoretical Framework

This study is underpinned by two complementary theoretical frameworks drawn from sustainability transitions research: the Multi-Level Perspective on sustainability transitions and the Technological Innovation Systems framework. These frameworks provide analytical lenses for understanding the complex dynamics shaping LNG adoption in Africa's maritime and logistics sectors. Their integration enables both macro-level analysis of transition pathways and meso-level examination of innovation system structures and functions.

2.1 Multi-Level Perspective on Sustainability Transitions

The Multi-Level Perspective, originally developed by Geels (2002), conceptualizes technological transitions emerging from interactions between three analytical levels: niche, regime, and landscape. This framework has been extensively applied to analyze transitions in the maritime sector, including studies of LNG adoption in Norway and broader shipping decarbonization



pathways (Baresic & Rehmatulla, 2024).

The landscape represents the exogenous environment that exerts pressure on existing regimes. In the context of this study, landscape factors include international regulatory frameworks such as the IMO's 2020 sulfur cap and 2023 GHG strategy creating mandatory pressure for emissions reduction (IMO, 2023). Global climate governance mechanisms including the Paris Agreement and UN Sustainable Development Goals, particularly SDG 13 on climate action, shape expectations and legitimize intervention in the maritime sector (Ezinna et al., 2021). Geopolitical shifts, most notably the Russia-Ukraine conflict, have restructured global gas trade flows and heightened European demand for LNG (Bilgili, 2025). Financial market trends, including growing ESG investment criteria and divestment from fossil fuels, increasingly affect project financing availability across developing economies (IMF, 2023).

The regime comprises established practices, rules, and institutions that create path dependency within the maritime and logistics sectors. For Africa's maritime and logistics sectors, regime elements include incumbent fuel infrastructure such as established heavy fuel oil bunkering networks, refueling stations, and supply chains that benefit from economies of scale and sunk investments. Regulatory frameworks encompassing national energy policies, port regulations, and environmental standards may either enable or constrain LNG adoption depending on their design and implementation. Industry practices reflect long-standing relationships between shipowners, fuel suppliers, and port operators that favor continuity over change. Technical standards embodied in existing vessel designs, engine technologies, and safety protocols are optimized for conventional fuels and may not readily accommodate alternative fuel systems.

Niches are protected spaces where radical innovations develop shielded from mainstream market selection. In the African context, niche innovations include FLNG technologies as demonstrated by projects like Mozambique's Coral Sul and Congo's Tango FLNG, which showcase offshore gas monetization possibilities (GIIGNL, 2024). LNG truck pilots, including Volvo and Renergen deployments along South Africa's N3 corridor, test heavy-duty vehicle applications under real-world operating conditions (Tlalat, 2024). Modular LNG solutions involving small-scale liquefaction plants enable distributed gas utilization across diverse geographic and market contexts (Energy Capital & Power, 2024). Bio-LNG experimentation, such as trials integrating agricultural residues with LNG infrastructure, points toward longer-term sustainability pathways (Maersk, 2024).

The MLP framework posits that transitions occur when landscape pressures create windows of opportunity, enabling niche innovations to break through and transform or replace existing regimes (Geels, 2002, 2012). This conceptualization is particularly relevant for analyzing how Africa's LNG potential might be realized, as international decarbonization mandates create landscape pressure that could catalyze adoption of FLNG and modular LNG technologies, which as niche innovations may gradually reshape Africa's energy infrastructure and maritime fuel supply systems through regime transformation.

Baresic and Rehmatulla's (2024) application of MLP to Norway's LNG transition reveals important insights for the African context. Their analysis demonstrates how early LNG adoption was driven by air pollution concerns and political considerations favoring domestic natural gas utilization,



which over time evolved under broader regulatory developments such as Emission Control Areas. However, by the 2010s, growing concerns about methane slip and less favorable gas market conditions slowed adoption. These findings highlight the dynamic nature of transitions and the importance of understanding how driver coalitions evolve, lessons directly applicable to analyzing Africa's emerging LNG landscape.

2.2 Technological Innovation Systems Framework

The Technological Innovation Systems framework, developed by scholars including Bergek et al. (2008) and Hekkert et al. (2007), provides analytical tools for assessing the structures and functions that enable or constrain the development and diffusion of new technologies. The TIS framework has been widely applied in African energy contexts, including analyses of improved cook stoves in Ghana and renewable energy innovation systems across the continent (Agbemabiese et al., 2012; Brew-Hammond, 2010).

A technological innovation system is defined as a network of agents interacting in a specific economic or industrial area under a particular institutional infrastructure and involved in the generation, diffusion, and utilization of technology (Bergek et al., 2008). The framework evaluates system performance through seven key functions: knowledge development and diffusion, influence on the direction of search, entrepreneurial experimentation, market formation, legitimation, resource mobilization, and development of positive externalities (Hekkert et al., 2007).

Knowledge development and diffusion encompasses the creation, sharing, and dissemination of knowledge relevant to the innovation. For Africa's LNG sector, this includes technical knowledge of LNG production, liquefaction, and transportation technologies; operational knowledge of bunkering procedures and safety protocols; market knowledge of pricing mechanisms, contract structures, and trading practices; and environmental knowledge of emissions performance and methane mitigation strategies. The limited diffusion of LNG-specific expertise across African markets represents a significant systemic weakness. While Mozambique's Coral Sul project has developed local technical capacity, knowledge remains concentrated in foreign operators with insufficient technology transfer to domestic institutions (IMF, 2023).

Influence on the direction of search relates to factors that shape expectations, articulate demand, and guide the allocation of resources toward technological pathways. Key influences include policy signals such as national energy strategies, LNG masterplans, and regulatory roadmaps; industry visions encompassing corporate commitments to decarbonization and fuel transition timelines; research priorities shaping knowledge trajectories; and market expectations regarding demand growth and price trends influencing investment decisions. South Africa's draft LNG for Transport Masterplan exemplifies efforts to influence direction, though implementation remains uncertain due to financing gaps and policy inconsistencies (Tlalang, 2024).

Entrepreneurial experimentation captures the activities of entrepreneurs testing new applications, business models, and technological configurations. African LNG experimentation includes FLNG deployments in Mozambique and Congo demonstrating offshore monetization (GIIGNL, 2024), HDV pilot projects in South Africa testing LNG truck economics (Tlalang, 2024), modular LNG initiatives exploring distributed infrastructure models (Energy Capital & Power, 2024), and bunkering hub developments at Nigeria's Lekki Deep Seaport (Osuji & Agbakwuru, 2024). These



experiments generate valuable learning about technological performance, economic viability, and operational requirements under African conditions.

Market formation addresses the creation of protected spaces where new technologies can mature before facing full market competition. Market formation mechanisms include niche markets where early adopters are willing to pay premiums for environmental performance, public procurement through government fleets transitioning to LNG vehicles, regulatory mandates requiring cleaner fuels in designated areas, and voluntary agreements wherein industry commits to adopting alternative fuels. Africa's LNG markets remain nascent, with limited demand from maritime operators and insufficient refueling infrastructure constraining heavy-duty vehicle adoption (Tlalang, 2024).

Legitimation involves social acceptance and political alignment necessary for innovation diffusion. This function encompasses regulatory approval through licensing, permitting, and safety certification; stakeholder acceptance reflected in community support, labor union attitudes, and public perception; policy alignment with broader energy and environmental objectives; and international recognition through compliance with global standards and treaties. Security challenges in Mozambique's Cabo Delgado region have undermined legitimation by creating perceptions of instability and risk (IMF, 2023). Similarly, environmental concerns about methane slip have complicated LNG's legitimation as a genuinely clean transition fuel (Pavlenko et al., 2020).

Resource mobilization concerns the allocation of financial, human, and physical resources to support innovation development. Critical resources include financial capital for project finance, equity investment, and development assistance; human capital embodied in technical expertise, managerial capacity, and operational skills; physical infrastructure including liquefaction plants, bunkering facilities, and distribution networks; and institutional resources such as regulatory agencies, research centers, and industry associations. The IMF (2023) estimates Africa faces a hundred-billion-dollar annual financing gap for gas infrastructure, with lenders increasingly prioritizing renewables, a systemic weakness severely constraining TIS development.

Development of positive externalities captures the emergence of system-level benefits that reinforce further innovation, including specialized supplier networks where local firms develop LNG-related capabilities; skilled labor pools of trained technicians and engineers available for new projects; knowledge spillovers where learning from early projects benefits later initiatives; and collective action through industry associations and research collaborations advancing shared interests. Congo's Tango FLNG project demonstrates potential for creating positive externalities through its modular approach, which could be replicated across emerging African gas producers (Energy Capital & Power, 2024).

The TIS framework enables systematic diagnosis of systemic strengths and weaknesses, identifying where policy interventions might most effectively accelerate innovation diffusion (Bergek et al., 2008). Agbemabiese et al's., (2012) application of TIS to Ghana's improved cook stove sector demonstrates how the framework can reveal critical blocking mechanisms including infrastructure deficits, institutional fragmentation, and financing constraints that closely parallel challenges facing Africa's LNG innovation system.



2.3 Rationale for Integrated MLP-TIS Approach

Recent scholarship has advocated for integrating MLP and TIS frameworks to capture both the multi-level dynamics of transitions and the functional dynamics of innovation systems. (Bakhuis et al., 2024) in their systematic review of multi-system innovation frameworks, identify three key aspects requiring attention in sustainability transitions research: the overarching directionality of multiple systems and their mutual influences; explicit analysis of transition phases for each system; and systematic configuration analysis including value chains, sectoral interactions, and technological complementarities.

The integrated MLP-TIS approach offers several advantages for this study. First, the frameworks provide complementary analytical focus, as MLP illuminates how landscape pressures create opportunities for niche innovations to challenge regimes, while TIS reveals the internal dynamics including knowledge flows, resource mobilization, and legitimation processes that determine whether niches can successfully scale (Geels, 2002; Bergek et al., 2008). Second, the integrated approach enables analysis of multi-system interactions, as Africa's LNG transition involves multiple interconnected systems including maritime fuel supply, road freight transport, electricity generation, and gas production, whose interactions require analysis beyond single-system frameworks. Third, the combined framework enables contextual sensitivity by facilitating attention to context-specific factors including political instability, infrastructure deficits, and institutional configurations that shape transition dynamics in developing economy settings. Fourth, the approach supports phase-sensitive analysis, as different transition phases including pre-development, take-off, acceleration, and stabilization require different analytical tools and policy responses, which the combined framework can accommodate.

Schaube's (2024) analysis of Argentine wind energy using integrated MLP-TIS demonstrates the framework's value for understanding transitions in emerging economy contexts characterized by macroeconomic volatility and policy discontinuities, conditions closely resembling those facing African LNG development. Similarly, research on Chinese wind turbine innovation systems shows how integrated analysis can reveal feedback loops between innovation functions and landscape dynamics that drive or constrain system expansion.

2.4 Application to This Study

This study applies to the integrated MLP-TIS framework across three analytical dimensions. Landscape-level analysis examines how international regulatory developments including IMO GHG strategy and Paris Agreement commitments, geopolitical shifts encompassing energy security concerns and Russia-Ukraine war impacts, and global financial trends such as ESG investment criteria and fossil fuel divestment create pressures and opportunities for African LNG development.

Regime-level analysis investigates the established structures including port authorities, fuel suppliers, shipping companies, and regulatory agencies whose practices and interests shape the context which LNG innovations must compete. Particular attention is paid to institutional configurations, policy frameworks, and infrastructure systems that create path dependency and lock-in, thereby constraining or enabling transition possibilities.



Niche-level analysis explores emerging LNG applications including FLNG projects in Mozambique and Congo, heavy-duty vehicle pilots in South Africa, and bunkering hub development in Nigeria as sites of entrepreneurial experimentation and learning. The TIS framework's seven functions guide systematic assessment of how these niches develop knowledge, mobilize resources, build legitimacy, and create positive externalities.

TIS functional analysis diagnoses systemic strengths and weaknesses across the seven functions, identifying critical blocking mechanisms and inducement factors that influence LNG diffusion trajectories. This analysis informs targeted policy recommendations designed to strengthen Africa's LNG innovation system. By integrating these analytical lenses, the study aims to generate theoretically grounded insights into how Africa's substantial LNG potential might be realized, what barriers must be overcome, and how policy interventions can accelerate sustainable transition pathways.

3. Literature Review

3.1 LNG as a Transitional Fuel: Environmental Performance and Technical Challenges

The maritime industry's shift toward LNG as a transitional fuel has been extensively documented in recent literature. Balcombe et al. (2019) conducted a comprehensive lifecycle analysis demonstrating that LNG can achieve twenty to thirty percent CO₂ reductions compared to conventional marine fuels like heavy fuel oil and marine diesel oil. This reduction is primarily attributed to LNG's higher hydrogen-to-carbon ratio and cleaner combustion properties. However, their study also cautioned that these benefits vary significantly depending on engine technology, with high-pressure dual-fuel engines showing better efficiency than older steam turbine systems (Balcombe et al., 2019).

A persistent challenge highlighted across multiple studies is methane slip, the unintended release of unburned methane during LNG combustion. Pavlenko et al. (2020) quantified that methane slip from marine engines could offset up to fifteen percent of LNG's climate benefits due to methane's high global warming potential of twenty-eight to thirty-six times CO₂ over one hundred years. Their research found that while modern lean-burn spark ignition engines have reduced slip to less than one percent of fuel consumption, older technologies still exhibit three to five percent methane leakage (Pavlenko et al., 2020). This has led to calls for IMO regulations on methane emissions and accelerated adoption of best available technologies.

More recent well-to-wake analyses have refined understanding of LNG's full lifecycle impacts. Zamboni et al. (2024) compared alternative marine fuels and found that while fossil LNG offers significant improvements over heavy fuel oil, the greatest emissions reductions come from bio-LNG and synthetic methane produced from renewable energy. Their analysis of cruise ship applications demonstrated that fuel production pathways dramatically influence overall climate performance, with green LNG achieving substantially lower carbon intensity than grey LNG from fossil sources.

Bilgili's (2025) comparative lifecycle assessment of natural gas supplies to Europe revealed



significant variations in environmental performance depending on production methods, transportation distances, and supply chain configurations. The study found that LNG transported from Canada to Germany causes approximately one hundred fifty tonnes of CO₂ equivalent per one million cubic meters, compared to over two thousand tonnes of CO₂ equivalent for Russian pipeline gas, highlighting how supply source and logistics configurations dramatically influence climate outcomes (Bilgili, 2025). These findings underscore the importance of considering full supply chain emissions when evaluating LNG's transition potential.

3.2 Bunkering Infrastructure and Vessel Adoption

The bunkering infrastructure required for widespread LNG adoption has been a focus of academic research. A 2023 study by DNV identified sixty-seven active LNG bunkering vessels globally but noted severe geographic concentration, with eighty-five percent of operations occurring in just three regions: Northwest Europe, East Asia, and North America (DNV, 2023). This creates a metaphorical chicken-and-egg problem for emerging markets, where lack of infrastructure discourages vessel adoption, and low demand discourages infrastructure investment.

The Norwegian experience offers valuable lessons for understanding infrastructure development dynamics. Baresic and Rehmatulla's (2024) analysis of Norway's LNG transition from 1985 to 2015 revealed how early infrastructure investments by technology champions including ferry operators, shipbuilders, and gas suppliers created demonstration effects that gradually built momentum. Their findings highlight the importance of strong technology champions and institutional modification requirements in overcoming initial infrastructure barriers. However, they also document how shifting priorities, particularly growing concerns about methane slip by the 2010s, eventually slowed adoption, demonstrating that transition pathways are not linear and may stall or reverse as new information emerges (Baresic & Rehmatulla, 2024).

(Laribi & Guy, 2020) examined how global regulations influenced local niche development for LNG in Norway, finding that international frameworks like International Convention for the prevention against pollution from ships (MARPOL) created critical windows of opportunity that enabled domestic actors to mobilize resources and build legitimacy. Their analysis underscores the importance of multi-level interactions, wherein landscape pressures enable niche development, that the MLP framework captures effectively.

3.3 Heavy-Duty Vehicle Applications: South African Evidence

South Africa's heavy transport sector has emerged as an unexpected testing ground for LNG applications. Tlalang's (2024) field study of one hundred fifty LNG trucks operating on the N3 corridor found fifteen to twenty percent lower CO₂ emissions compared to diesel equivalents, along with fifty percent reductions in particulate matter. The economic case appears compelling, with operational savings of R3.03 per kilometer yielding payback periods of one to three years for fleet operators, a finding corroborated by Volvo's South African pilot program (Tlalang, 2024).

However, infrastructure limitations remain a critical barrier. As of 2024, South Africa had only three operational LNG refueling stations, all located along the Durban-Johannesburg route (Tlalang,



2024). This contrasts sharply with China's network of over five thousand LNG stations (GIIGNL, 2024) and raises questions about scalability. The South African government's draft LNG for Transport Masterplan proposes fifty stations by 2030, but financing mechanisms remain unclear.

From a TIS perspective, South Africa's heavy-duty vehicle LNG sector exhibits significant functional weaknesses including limited knowledge diffusion beyond pilot participants, insufficient resource mobilization for infrastructure expansion, and incomplete legitimization due to policy uncertainties around carbon taxation (Tlalang, 2024). These systemic barriers require coordinated policy responses that the TIS framework helps identify.

3.4 Africa's LNG Market Potential: Country-Specific Analysis

The 2024 GIIGNL report provides crucial insights into Africa's evolving LNG landscape across key markets. Nigeria, despite being Africa's LNG leader, saw exports decline to 13.0 million tonnes in 2023, a decrease of 1.5 million tonnes, due to feedstock shortages at Bonny Island (GIIGNL, 2024). The ongoing Train 7 expansion, now fifty-two percent complete as of the second quarter of 2024, promises to add eight million tonnes per annum capacity, but chronic upstream issues including pipeline vandalism and underinvestment continue to constrain output (NNPC, 2023). Osuji and Agbakwuru (2024) argue that Nigeria's Lekki Deep Seaport bunkering hub, once operational, could transform regional LNG distribution but note delays in regulatory approvals.

Mozambique's Coral Sul FLNG project added 2.6 million tonnes to Mozambique's exports in 2023, yet security concerns in Cabo Delgado have delayed the larger Rovuma LNG onshore project (IMF, 2023). TotalEnergies' planned 2024 restart depends on SADC military deployment success, highlighting the geopolitical risks facing African LNG. From an MLP perspective, security challenges represent landscape-level factors disrupting niche development and regime transformation.

As Africa's newest LNG exporter, Congo's Tango FLNG, with 0.7 million tonnes per annum capacity, began operations in the first quarter of 2024. With a second 3.5 billion cubic meters per annum FLNG unit planned for 2025, Congo exemplifies the small-scale LNG trend enabling faster project sanctioning (Energy Capital & Power, 2024). This modular approach demonstrates how technological configurations can be adapted to local conditions, representing a niche innovation with potential for replication across emerging African gas producers.

Emerging producers also show significant potential. Senegal and Mauritania's Grand Tortue Ahmeyim project, targeting 2.5 million tonnes per annum initially, represents another significant development, though technical challenges have delayed first gas (BP, 2023). Tanzania's delayed LNG project, pending resolution of fiscal terms with international partners, illustrates how policy inconsistencies can block otherwise viable developments.

3.5 Key Challenges and Research Gaps

Three critical hurdles constrain Africa's LNG sector development. First, financing gaps persist, with the IMF (2023) estimating a one hundred billion dollar annual shortfall for gas infrastructure, as lenders increasingly prioritize renewables, evidenced by Mozambique's Rovuma LNG missing



its 2023 final investment decision deadline due to funding uncertainties. Second, policy inconsistencies undermine progress, such as Nigeria's Petroleum Industry Act, which introduced fiscal unpredictability (Osuji & Agbakwuru, 2024), and South Africa's carbon tax regime, which inadvertently penalizes LNG trucks compared to electric alternatives (Talang, 2024). Third, security risks, like the Cabo Delgado insurgency, have inflated project risk premiums by fifteen to twenty percent in Mozambique, further deterring investment (IMF, 2023).

Research gaps are equally significant. Academic and industry research fails to address key aspects of Africa's LNG potential. Only twelve percent of LNG-focused studies examine financing mechanisms for African projects, despite the continent's vast 210.8 trillion cubic feet of gas reserves (BP, 2023). Additionally, no peer-reviewed studies comprehensively assess lifecycle emissions for African LNG, particularly regarding flaring reductions and methane leakage in pipelines. Furthermore, while Congo's Tango FLNG showcases small-scale LNG potential, literature lacks comparative analyses of FLNG versus onshore plant economics in African contexts, leaving critical deployment strategies unexplored.

The theoretical literature on sustainability transitions has also neglected African energy contexts. Most MLP and TIS applications focus on European or Asian cases, with limited attention to the specific institutional, political, and economic configurations shaping transitions in developing economies. This study addresses this gap by applying these frameworks to Africa's emerging LNG sector.

4. Research Design and Methodology

4.1 Research Paradigm and Design

This study adopts a pragmatist research paradigm, recognizing that complex socio-technical transitions require methodological pluralism to capture both quantitative performance metrics and qualitative contextual dynamics. The research design integrates multiple methods within a case study framework, enabling in-depth investigation of Africa's LNG landscape while maintaining analytical rigor.

The design is structured around Yin's (2018) multiple-case study approach, with cases selected to represent variation across key dimensions including geographic region, technology type distinguishing FLNG from onshore operations, market maturity, and policy context. This design enables both within-case analysis of transition dynamics and cross-case comparison to identify patterns and contingencies shaping LNG development across diverse African settings.

4.2 Research Approach

The study employs a mixed-methods approach, strategically combining quantitative and qualitative methodologies to provide comprehensive analysis of LNG's role in sustainable logistics and maritime decarbonization. The quantitative component leverages authoritative industry datasets, including the 2024 GIIGNL Annual Report and 2024 World LNG Report, which provide critical metrics on global LNG trade volumes, infrastructure development, and market trends (GIIGNL, 2024; IGU, 2024). These datasets are supplemented by microeconomic analyses of



South Africa's heavy-duty vehicle sector, particularly Tlalang's (2024) cost-benefit assessment of LNG adoption in freight transport, which offers granular insights into operational savings, emission reductions, and payback periods for fleet operators.

The qualitative dimension involves systematic review of peer-reviewed articles published between 2018 and 2024, selected through rigorous screening to ensure relevance to LNG's decarbonization potential and sustainability transitions frameworks. Key sources analyzed include (Baresic & Rehmatulla, 2024) MLP analysis of Norwegian LNG adoption, (Agbemabiese et al., 2012) TIS application to Ghanaian energy innovation, and Zamboni et al.'s (2024) well-to-wake assessment of alternative marine fuels. This dual methodology enables both macro-level trend analysis and nuanced, context-specific insights, ensuring balanced assessment of LNG's opportunities and challenges.

4.3 Research Method: Case Studies

To ground the research in practical applications, five case studies were selected, representing diverse facets of Africa's LNG landscape. The first case, Coral Sul FLNG in Mozambique, represents a pioneering floating LNG facility operational since 2022 that serves as a critical test case for offshore gas monetization in conflict-prone regions. The study examines its production capacity of 3.4 million tonnes per annum, security challenges in Cabo Delgado, and its role in establishing Mozambique as a global LNG exporter, drawing on IMF (2023) assessments and industry reporting.

The second case, Nigeria LNG Train 7, currently at fifty-two percent completion, aims to increase Nigeria's LNG output by thirty-five percent. The study focuses on its engineering innovations, local content policies, and feedstock supply constraints that led to a 1.5 million tonne export decline in 2023, drawing on GIIGNL (2024) and NNPC (2023) reports.

The third case, Congo's Tango FLNG, represents Africa's newest LNG exporter as of 2024, with its modular FLNG approach offering insights into low-cost, rapid-deployment strategies for emerging as producers. Analysis draws on Energy Capital and Power (2024) reporting and GIIGNL (2024) data to assess the potential for replication across similar contexts.

The fourth case, Nigeria's Lekki Bunkering Hub, is analyzed through Osuji and Agbakwuru's (2024) framework to evaluate the hub's potential to transform West Africa's maritime fuel supply chain, while highlighting delays in bunkering service rollouts and regulatory approval processes that constrain market development.

The fifth case, South Africa's heavy-duty vehicle LNG pilots, focuses on deployments by Volvo Trucks and Renergen to assess real-world performance data including fifteen to twenty percent CO₂ reductions and R3.03 per kilometer cost savings, while scrutinizing infrastructure gaps along the N3 highway corridor that limit scalability (Tlalang, 2024).

4.4 Data Collection and Analysis

Data collection occurred between September and December 2025, drawing on multiple sources



including industry reports from GIIGNL (2024), IGU (2024), DNV (2023), and the IMF (2023); academic literature identified through systematic database searches of Scopus, Web of Science, and Google Scholar using keywords including LNG, maritime decarbonization, Africa, FLNG, Multi-Level Perspective, and Technological Innovation Systems; grey literature comprising government policy documents, industry association publications, and corporate sustainability reports; and case study documents including project technical reports, environmental impact assessments, and media coverage.

Data analysis employed theory-guided content analysis, using MLP and TIS frameworks as analytical lenses. For each case, landscape pressures including international regulations, geopolitical shifts, and market trends were identified; regime structures encompassing incumbent actors, institutional arrangements, and infrastructure systems were analyzed; niche innovations comprising new technologies, business models, and actor configurations were documented; and TIS functional performance across the seven functions including knowledge development, direction of search, entrepreneurial experimentation, market formation, legitimation, resource mobilization, and positive externalities was assessed following the approach outlined by Bergek et al. (2008). Cross-case analysis identified patterns across cases, informing development of policy recommendations.



4.5 Ethical Considerations

This study relied exclusively on publicly available documents and published research, raising no direct ethical concerns regarding human subjects. All sources are appropriately cited, and findings are presented objectively without misrepresentation. The research acknowledges potential biases in industry-reported data and addresses these through triangulation with academic literature and independent assessments.

4.6 Limitations

While this methodology provides robust insights, several limitations warrant acknowledgment. Dependence on corporate and governmental LNG datasets based on GIIGNL and IGU introduces potential commercial bias risks, which are mitigated through triangulation with peer-reviewed academic literature and independent assessments. Critical metrics on well-to-wake emissions for African LNG projects remain sparse, particularly regarding methane leakage rates during gas flaring and transportation, restricting full assessment of LNG's net decarbonization benefit in the region and suggesting the need for localized emissions monitoring initiatives. The rapidly evolving LNG landscape means findings reflect information available as of mid-2024 and may require updating as new developments occur. Reliance on published sources means the study lacks primary interview data from key stakeholders including policymakers, industry executives, and community representatives that might reveal additional insights, suggesting future research should address this gap through field research.

5. Results and Findings: Theoretical Application and Analysis

This section presents findings organized around the integrated MLP-TIS framework, demonstrating how theoretical lenses illuminate the dynamics shaping Africa's LNG landscape.

5.1 Landscape-Level Pressures and Opportunities

Analysis reveals multiple landscape factors creating windows of opportunity for African LNG development. International regulatory pressures, particularly the IMO's 2023 GHG Strategy calling for net-zero shipping emissions by 2050, represent significant landscape pressure creating demand for cleaner marine fuels (IMO, 2023). This regulatory trajectory advantages LNG relative to heavy fuel oil while creating expectations of eventual transition to zero-carbon fuels. As Baresic and Rehmatulla (2024) found in the Norwegian context, such regulatory developments can create windows of opportunity that enable niche innovations to challenge established regimes.

Geopolitical restructuring following Russia's invasion of Ukraine has fundamentally restructured global gas trade flows, with European demand for LNG surging as pipeline gas from Russia declines (Bilgili, 2025). This creates market opportunities for African producers capable of responding quickly, as evidenced by increased interest in Nigerian and Mozambican supplies. However, it also creates risks of lock-in to fossil infrastructure that may become stranded as Europe accelerates its own energy transition.

Financial market evolution, characterized by growing ESG investment criteria and lender commitments to net-zero portfolios, creates both constraints and opportunities. While some financiers are divesting from fossil fuels, others recognize LNG's transitional role and are



developing transition finance frameworks (IMF, 2023). The challenge for African projects is demonstrating alignment with credible transition pathways that satisfy evolving investor expectations.

Climate science imperatives embodied in the Paris Agreement's 1.5 degree Celsius temperature goal and accumulating evidence of climate impacts create normative pressure for emissions reduction across all sectors. For LNG, this pressure manifests in growing scrutiny of methane emissions and demands for lifecycle emissions accounting that captures the full climate implications of production, transport, and combustion (Pavlenko et al., 2020; Zamboni et al., 2024).

5.2 Regime-Level Structures and Lock-in

Analysis of regime-level structures across African markets reveals significant heterogeneity but common patterns of lock-in and resistance that constrain transition possibilities. Infrastructure lock-in manifests in existing port infrastructure designed primarily for bulk liquids and containers requiring significant adaptation for LNG bunkering. The costs and coordination challenges of retrofitting create inertia favoring incumbent fuels, with South Africa's lack of LNG import terminals exemplifying this lock-in by forcing heavy-duty vehicle pilots to rely on small-scale solutions that cannot achieve economies of scale (Tlalang, 2024).

Institutional lock-in arises from regulatory frameworks developed for conventional fuels that often create barriers for LNG. Nigeria's Petroleum Industry Act, while intended to modernize governance, introduced fiscal uncertainties that have complicated investment decisions (Osuji & Agbakwuru, 2024). Similarly, South Africa's carbon tax regime, designed without considering LNG's transitional role, has inadvertently penalized early adopters and created disincentives for fleet operators considering fuel switching (Tlalang, 2024).

Actor lock-in reflects the interests of incumbent fuel suppliers, shipping companies, and port operators who have invested heavily in heavy fuel oil infrastructure and may resist transitions that strand assets. However, some actors including Volvo Trucks in South Africa are positioning as first movers, recognizing competitive advantages in early adoption and seeking to shape market development in ways that favor their strategic interests.

5.3 Niche-Level Innovations and TIS Functional Analysis

Analysis of niche innovations across the five cases reveals significant variation in TIS functional performance that shapes transition trajectories. For Mozambique's Coral Sul FLNG, knowledge development is assessed as moderate, with technology transfer from foreign operators limited and local capacity building constrained by the security situation (IMF, 2023). Direction of search is strong, reflecting clear government commitment to LNG monetization and sustained investor interest despite challenges. Entrepreneurial experimentation is strong, with the first-mover FLNG deployment demonstrating technical feasibility under challenging conditions (GIIGNL, 2024). Market formation is moderate, with European buyers secured through long-term contracts. Legitimation is weak, as security concerns undermine legitimacy and environmental groups raise questions about project impacts. Resource mobilization is moderate, with the project achieving



final investment decision but subsequent financing constrained by ongoing uncertainties. Positive externalities are emerging through supply chain development and potential for replication in similar contexts.

Case 1: Coral Sul FLNG (Mozambique)

TIS Function	Assessment	Evidence
<i>Knowledge Development</i>	Moderate	Technology transfer from foreign operators limited; local capacity building constrained by security situation (IMF, 2023)
<i>Direction of Search</i>	Strong	Clear government commitment to LNG monetization; investor interest despite challenges
TIS Function	Assessment	Evidence
<i>Entrepreneurial Experimentation</i>	Strong	First-mover FLNG deployment demonstrating technical feasibility
<i>Market Formation</i>	Moderate	European buyers secured; long-term contracts in place
<i>Legitimation</i>	Weak	Security concerns undermining legitimacy; environmental groups raising concerns
<i>Resource Mobilization</i>	Moderate	Project achieved FID but subsequent financing constrained
<i>Positive Externalities</i>	Emerging	Supply chain development; potential for replication

For Nigeria's mature LNG sector, knowledge development is strong, reflecting long-standing LNG expertise developed through the NLNG joint venture (GIIGNL, 2024). Direction of search is strong, with expansion consistent with national strategy and clear government prioritization. Entrepreneurial experimentation is moderate, as Train 7 represents expansion rather than radical innovation. Market formation is strong, with established customer base and competitive positioning in global markets. Legitimation is moderate, as feedstock diversion and pipeline vandalism undermine reliability perceptions among customers and investors (NNPC, 2023). Resource mobilization is moderate, with financing secured but upstream investment gaps constraining feedstock availability. Positive externalities are strong, with local content requirements building domestic capabilities and supply chain development generating broader economic benefits.



Coral Sul demonstrates how niche innovations can achieve technical success despite challenging contexts, yet TIS functional weaknesses—particularly in legitimation and resource mobilization—limit scaling potential. The security situation in Cabo Delgado represents a landscape-level factor that has severely disrupted TIS development.

Case 2: Nigeria LNG Train 7

TIS Function	Assessment	Evidence
Knowledge Development	Strong	Long-standing LNG expertise through NLNG joint venture
Direction of Search	Strong	Clear government priority; expansion consistent with national strategy
Entrepreneurial Experimentation	Moderate	Train 7 represents expansion rather than radical innovation
Market Formation	Strong	Established customer base; competitive positioning
Legitimation	Moderate	Feedstock diversion and pipeline vandalism undermining reliability perceptions
Resource Mobilization	Moderate	Financing secured but upstream investment gaps constrain feedstock
Positive Externalities	Strong	Local content requirements building domestic capabilities

Nigeria's mature LNG sector demonstrates stronger TIS functions overall, yet feedstock constraints reveal how regime-level issues (upstream underinvestment, pipeline vandalism) can undermine otherwise robust innovation systems.

For Congo's modular FLNG approach, knowledge development is emerging, with modular FLNG expertise developing through international partnership. Direction of search is strong, reflecting government commitment to rapid monetization (Energy Capital & Power, 2024). Entrepreneurial experimentation is strong, with the novel modular approach demonstrating an alternative pathway for emerging producers. Market formation is emerging, with initial cargoes secured but scaling needed to achieve full potential. Legitimation is strong, as rapid execution builds confidence among investors and partners. Resource mobilization is moderate, with project-specific financing secured. Positive externalities are emerging through demonstration effects that may benefit other



emerging producers considering similar approaches.

Case 3: Congo's Tango FLNG

TIS Function	Assessment	Evidence
Knowledge Development	Emerging	Modular FLNG expertise developing through partnership
Direction of Search	Strong	Government commitment to rapid monetization
Entrepreneurial Experimentation	Strong	Novel modular approach demonstrating alternative pathway
Market Formation	Emerging	Initial cargoes secured; scaling needed
Legitimation	Strong	Rapid execution building confidence
Resource Mobilization	Moderate	Project-specific financing secured
Positive Externalities	Emerging	Demonstration effect for modular approach

Congo's modular FLNG approach exemplifies niche innovation with potential for replication across emerging African producers. The rapid 28-month timeline from FID to first gas (Energy Capital & Power, 2024) demonstrates how technological choices can mitigate context-specific barriers.

For Nigeria's Lekki Bunkering Hub, knowledge development is moderate, with bunkering expertise developing through port development processes. Direction of search is strong, reflecting strategic priority for establishing West African maritime hub. Entrepreneurial experimentation is emerging, with new business models being tested. Market formation is weak, as delayed operationalization limits market development and constrains demand (Akintoye et al., 2016; Osuji & Agbakwuru, 2024). Legitimation is moderate, with strategic importance recognized but implementation delays concerning stakeholders. Resource mobilization is moderate, with infrastructure investments made but operational funding needed. Positive externalities are emerging through potential for regional supply chain transformation.



Case 4: Nigeria's Lekki Bunkering Hub

TIS Function	Assessment	Evidence
Knowledge Development	Moderate	Bunkering expertise developing through port development
Direction of Search	Strong	Strategic priority for West African maritime hub
Entrepreneurial Experimentation	Emerging	New business models being tested
Market Formation	Weak	Delayed operationalization limiting market development
Legitimation	Moderate	Strategic importance recognized; implementation delays concerning
Resource Mobilization	Moderate	Infrastructure investments made; operational funding needed
Positive Externalities	Emerging	Potential for regional supply chain transformation

The Lekki case illustrates how regulatory delays and coordination failures can block market formation even when infrastructure investments are made—a classic TIS weakness requiring policy attention.

For South Africa's heavy-duty vehicle LNG pilots, knowledge development is moderate, with pilot learning documented but diffusion limited beyond participating firms (Tlalang, 2024). Direction of search is weak, as policy uncertainty undermines clear direction for investors and operators. Entrepreneurial experimentation is strong, with Volvo and Renergen demonstrating technical feasibility under real-world conditions. Market formation is weak, with only three refueling stations insufficient for scaling operations. Legitimation is moderate, with economic benefits recognized but policy gaps concerning stakeholders. Resource mobilization is weak, with infrastructure financing unclear and government support uncertain. Positive externalities are emerging through operational experience and maintenance capability development.



Case 5: South Africa HDV LNG Pilots

TIS Function	Assessment	Evidence
Knowledge Development	Moderate	Pilot learning documented; diffusion limited
Direction of Search	Weak	Policy uncertainty undermining clear direction
Entrepreneurial Experimentation	Strong	Volvo, Renergen demonstrating technical feasibility
Market Formation	Weak	Only three refueling stations; insufficient for scaling
Legitimation	Moderate	Economic benefits recognized; policy gaps concerning
Resource Mobilization	Weak	Infrastructure financing unclear; government support uncertain
Positive Externalities	Emerging	Operational experience; maintenance capability developing

South Africa's HDV sector reveals critical TIS weaknesses in market formation and resource mobilization that prevent scaling despite demonstrated technical and economic viability. Policy uncertainties around carbon taxation and infrastructure support are key blocking mechanisms

5.4 Cross-Case Analysis: Patterns and Implications

Cross-case analysis reveals several patterns with theoretical and practical implications for understanding and accelerating LNG transitions in Africa. The first pattern concerns TIS functional configurations shaping transition trajectories, with cases demonstrating stronger functional performance across multiple TIS dimensions exhibiting more advanced transition trajectories than those with concentrated weaknesses. Nigeria's relatively balanced functional development contrasts with Mozambique's legitimation crisis and South Africa's market formation failure, suggesting that innovation systems require reasonably balanced functional development for sustained growth (Bergek et al., 2008).

The second pattern involves landscape factors mediating niche development, as security challenges in Mozambique, geopolitical shifts driving European demand, and international climate policy all demonstrate how landscape factors create both opportunities and constraints for niche development. The MLP framework's attention to multi-level interactions proves essential for understanding these dynamics and anticipating how landscape changes may create or close windows of opportunity (Geels, 2002; Baresic & Rehmatulla, 2024).



The third pattern identifies policy fragmentation as systemic weakness across all cases, with policy inconsistencies including taxation uncertainties in South Africa, fiscal unpredictability in Nigeria, and regulatory delays at Lekki emerging as critical blocking mechanisms. This finding underscores the importance of institutional configuration in TIS development and suggests that policy coordination may be as important as resource mobilization for accelerating transitions.

The fourth pattern reveals technological choices mediating contextual barriers, as Congo's modular FLNG approach demonstrates how technological configurations can mitigate context-specific challenges including security risks, financing constraints, and infrastructure deficits (Energy Capital & Power, 2024). This finding supports attention to technological heterogeneity in transition analysis and suggests that appropriate technology choice can significantly influence transition feasibility in challenging contexts.

The fifth pattern concerns legitimation challenges undermining otherwise viable niches, as Mozambique's security situation and growing environmental scrutiny of methane emissions both illustrate how legitimation failures can block transition pathways even when technical and economic viability is demonstrated (IMF, 2023; Pavlenko et al., 2020). This highlights the importance of social and political dimensions in sustainability transitions and suggests that legitimation strategies require as much attention as technical and economic considerations.

6. Managerial Implications

6.1 Implications for Policymakers

The analysis reveals policy fragmentation as a critical barrier across African markets, suggesting that policymakers should develop comprehensive LNG strategies addressing multiple dimensions simultaneously. Such strategies should include fiscal incentives for infrastructure investment that recognize the public goods aspects of early-stage infrastructure development. Regulatory harmonization across ports and borders can reduce compliance costs and attract international operators by creating predictable operating environments (Osuji & Agbakwuru, 2024). Carbon pricing calibrated to support transitional fuels rather than inadvertently penalizing them requires careful design that considers the full context of fuel competition (Tlalang, 2024). Local content requirements that build domestic capabilities without deterring investment necessitate balancing short-term costs against long-term development benefits.

The AfCFTA framework provides an opportunity for coordinated LNG development across the continent, suggesting that policymakers should establish an African LNG Task Force to harmonize standards, share best practices, and coordinate infrastructure planning. The European Union's TEN-E framework for energy infrastructure coordination offers a potential model, though adaptation to African institutional contexts would be necessary. Such coordination could reduce duplication, accelerate learning, and create larger markets that justify infrastructure investments.

Legitimation challenges require proactive management through multiple channels. Security concerns in Mozambique demonstrate the need for strengthened security provision in gas-rich regions, potentially through regional cooperation mechanisms (IMF, 2023). Environmental concerns about methane require robust methane monitoring and reporting systems that document



environmental performance credibly (Pavlenko et al., 2020). Community engagement processes that communicate project benefits and risks transparently can build social license and reduce opposition. Articulating clear transition pathways from LNG to zero-carbon fuels addresses concerns about lock-in and demonstrates alignment with long-term climate goals.

Given the estimated one hundred billion dollar annual financing gap, policymakers should explore innovative financing mechanisms including blended finance combining development finance with private capital, green bonds structured for transitional energy investments, and risk mitigation instruments addressing political and security risks (IMF, 2023). Multilateral development banks have particular roles to play in de-risking early-stage investments and demonstrating project viability that can crowd in private capital.

6.2 Implications for Industry

Industry actors should invest in knowledge development and diffusion through training programs, technology transfer arrangements, and knowledge-sharing platforms that strengthen TIS knowledge functions. Partnerships with local universities and technical colleges can build domestic capabilities while demonstrating commitment to local development and creating pipelines of skilled personnel for industry operations. Such investments generate positive externalities that benefit the broader innovation system while building goodwill with host communities and governments.

Given growing scrutiny of methane emissions, LNG operators should implement robust monitoring, reporting, and verification systems that document environmental performance credibly (Pavlenko et al., 2020). Third-party certification of emissions reductions can enhance legitimation by providing independent validation of environmental claims. Participation in industry initiatives to develop and share best practices for methane management can demonstrate leadership while accelerating learning across the sector.

Congo's Tango FLNG demonstrates the potential of modular approaches for contexts characterized by uncertainty and resource constraints (Energy Capital & Power, 2024). Industry should explore similar approaches for LNG infrastructure including small-scale liquefaction, mobile bunkering units, and distributed storage that enable incremental scaling and reduce upfront capital requirements. Such approaches may prove particularly suitable for emerging markets where demand uncertainty and financing constraints make large-scale projects challenging.

The problem of infrastructure and demand requires coordinated action that individual firms cannot achieve alone. Industry should engage with port authorities, shipping lines, logistics operators, and government agencies to develop coordinated infrastructure plans and shared risk arrangements. Public-private partnerships that align incentives and distribute risks appropriately can accelerate development while ensuring that benefits are shared among stakeholders.

6.3 Implications for Investors

Investment decisions should consider not only project-specific economics but also the broader innovation system context within which projects operate. Projects in systems with balanced functional development across multiple TIS dimensions present lower risk than those with



concentrated weaknesses, as systemic strengths provide resilience and support when individual challenges arise (Bergek et al., 2008). This suggests that due diligence should extend beyond project boundaries to assess the enabling environment.

Given policy fragmentation as a key risk, investors should engage proactively with policymakers to shape regulatory frameworks, advocate for fiscal stability, and build relationships that facilitate problem-solving when challenges arise. Such engagement can reduce policy risk while demonstrating commitment to host countries, potentially opening doors to additional opportunities.

First-mover projects create valuable demonstration effects that can accelerate system development by revealing technical feasibility, demonstrating economic viability, and building confidence among potential adopters (Baresic & Rehmatulla, 2024). Investors should recognize the systemic value of pioneering investments and consider how portfolio strategies can support niche development across multiple contexts. However, such investments require appropriate risk pricing and may benefit from risk mitigation instruments that recognize their demonstration value.

7. Conclusions and Future Research

7.1 Theoretical Contributions

This study makes several contributions to sustainability transitions theory through its application of integrated MLP-TIS frameworks to Africa's emerging LNG sector. By extending transitions research beyond its traditional European and Asian focus, the findings demonstrate the framework's utility for analyzing developing economy contexts characterized by different institutional configurations, governance capacities, and risk profiles than those typically studied in transitions scholarship (Geels, 2002; Bergek et al., 2008). The identification of context-specific dynamics including security risks as legitimation challenges, policy fragmentation as systemic weakness, and modular technologies as barrier-mitigation strategies extends theoretical understanding of how transitions unfold in settings where conventional assumptions about institutional stability and policy coherence may not hold.

Following recent calls for multi-system analysis (Bakhuis et al., 2024), the study demonstrates how integrated MLP-TIS approach can illuminate both multi-level transition dynamics and innovation system functions. Cross-case analysis reveals how landscape pressures interact with TIS functional configurations to shape transition trajectories, with the relative balance of functional strengths and weaknesses mediating how niches respond to landscape-level opportunities and constraints. This suggests that future theoretical development should attend more carefully to the interactions between levels and functions, rather than treating them as separate analytical domains.

The identification of context-specific dynamics including security risks as legitimation challenges, policy fragmentation as systemic weakness, and modular technologies as barrier-mitigation strategies extends theoretical understanding of transitions in developing economies. These findings suggest that transition frameworks developed primarily in Western European contexts may require adaptation when applied to settings characterized by different configurations of risk,



institutional capacity, and resource availability.

7.2 Policy Recommendations

Based on the analysis, several policy recommendations emerge for accelerating sustainable LNG development in Africa. Establishing an African LNG Task Force under AfCFTA auspices would provide a platform for harmonizing standards, coordinating infrastructure planning, and sharing best practices across member states. Developing national LNG masterplans with clear timelines, infrastructure roadmaps, and financing strategies would provide direction and predictability for investors while ensuring alignment with broader development objectives. Implementing methane monitoring regulations requiring robust monitoring, reporting, and verification systems with public reporting would address legitimization concerns while building credibility for LNG's environmental claims (Pavlenko et al., 2020).

Creating transition finance frameworks that recognize LNG's transitional role while supporting eventual shift to zero-carbon fuels would align financing with climate objectives while enabling needed infrastructure development (IMF, 2023). Strengthening security provision in gas-rich regions through regional cooperation and community engagement would address legitimization challenges that currently undermine investment in otherwise viable projects. Supporting demonstration projects through public-private partnerships that share risks and build evidence would accelerate learning while demonstrating viability to potential adopters. Investing in human capital development through training programs, technology transfer, and university partnerships would build domestic capabilities while generating positive externalities for broader economic development.

7.4 Future Research Directions

Several avenues for future research emerge from this study's limitations and findings. Longitudinal analysis tracking TIS functional development and transition trajectories over time would provide valuable insights into dynamics that cross-sectional research cannot capture, revealing how systems evolve in response to policy interventions and landscape changes. Comparative research examining LNG transitions across multiple developing economy contexts could identify patterns and contingencies extending beyond Africa, building a broader evidence base for transition theory and policy guidance.

Actor-level analysis examining strategies, perceptions, and interactions of key actors including policymakers, industry executives, and community representatives would complement the system-level focus of this study by revealing how individual and organizational agency shapes transition outcomes. Quantitative modeling of transition pathways could complement qualitative analysis by exploring counterfactual scenarios and testing policy interventions under controlled assumptions, generating insights about leverage points and intervention effectiveness.

Primary research measuring methane emissions from African LNG operations would address critical data gaps that currently constrain full assessment of LNG's climate implications in the region (Pavlenko et al., 2020). Such research could inform evidence-based policymaking while building local research capacity. Finally, research examining pathways for integrating bio-LNG

and hydrogen with LNG infrastructure would support transition planning by identifying feasible sequences and combinations that can bridge from current fossil dependence to longer-term zero-carbon systems (Zamboni et al., 2024).



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Enhancing Efficiency in Food Processing: Modeling and Simulation Techniques for Optimizing Peeling Operations

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Abstracts

Modeling and simulation of peeling processes have gained significant traction in recent years due to their critical relevance in the food processing industry. This work provides a comprehensive overview of current trends in the modeling and simulation of peeling operations, focusing on various physical processing models, including fundamental analytical models, finite element models, and molecular dynamics models. Key process conditions, such as peeling force, feed rate, and tool geometry, are examined to characterize these models and their implications for optimizing peeling efficiency. The findings underscore the importance of these techniques in reducing waste, enhancing product quality, and improving overall operational efficiency. Additionally, the limitations and capabilities of the different modeling approaches are discussed, highlighting the need for further research to drive innovation in the design and implementation of effective peeling processes. This paper aims to contribute valuable insights that can facilitate advancements in food processing technology, ultimately leading to more efficient and sustainable practices in the industry.

Keywords: efficiency optimization, food processing, modelling technique, peeling process, simulation.

Introduction

Food processing is a critical component of the global food supply chain, significantly contributing to national economies and ensuring food safety and quality (Aworh, 2021; Pokharel et al. 2023; Pandey et al. 2023; Amorim et al. 2023; and Michel et al. 2024). Among the various operations involved in food processing, peeling plays a pivotal role, particularly in the preparation of vegetables and tubers (Kohli et al. 2021; Eslami et al. 2024; Sakthivel et al. 2025). Efficient peeling not only enhances the aesthetic appeal of food products but also minimizes waste, thereby maximizing the yield of valuable edible portions.

Recent advancements in modeling and simulation techniques have transformed the way peeling processes are analyzed and optimized (da Silva et al. 2012; Edeh et al. 2022; Ali et al. 2024). These techniques facilitate a deeper understanding of the dynamics involved in peeling operations, enabling engineers and researchers to design more efficient peeling machines. For instance, the integration of modeling approaches such as Kinematic Models, Finite Element Models, and Molecular Dynamics Models allows for a comprehensive analysis of various factors influencing peeling efficiency, including peeling force, feed rate, and tool geometry (Han et al. 2022; Hashmi et al. 2022; Chauhan et al. 2023; Korkmas et al. 2023). Research indicates that the application of these modeling techniques can lead to significant improvements in process efficiency (Rosova et al. 2022). For example, studies have shown that optimizing peeling conditions can reduce the amount of edible flesh lost during peeling, which is crucial for both economic and sustainability reasons (Zhang et al. 2024). Furthermore, by simulating different



peeling scenarios, researchers can identify bottlenecks and inefficiencies in the process, paving the way for innovations that enhance productivity.

This paper aims to provide an overview of the current trends in modeling and simulation of peeling processes. It will discuss different physical processing models, including fundamental analytical models, finite element models, and kinematic models, with a focus on their capabilities and limitations. Additionally, the paper will highlight the implications of these models for future research and practical applications in the food processing industry. Overall, a thorough understanding of the modeling and simulation of peeling operations not only contributes to the advancement of food processing technology but also supports the industry's efforts to optimize resource use and reduce waste. By consolidating insights from diverse modeling frameworks, this paper seeks to establish a coherent knowledge base that supports improved decision-making in the design and operation of efficient peeling systems.

1.1 Practical Applications

The practical applications of modeling and simulation techniques in peeling operations are vast and impactful, addressing critical challenges within the food processing industry. Efficient peeling methods are essential for enhancing product quality while minimizing waste, thereby supporting sustainability and profitability in food production. By optimizing peeling processes through advanced modeling, manufacturers can significantly reduce the amount of edible flesh lost during peeling, particularly for high-value crops like avocados and kiwifruits, where even small amounts of waste can lead to substantial financial losses. Additionally, computational models streamline peeling operations by predicting stresses and strains experienced by peeling tools, leading to better tool design and material selection, which results in longer tool life and reduced downtime due to maintenance. These modeling techniques also enable real-time monitoring of peeling processes, facilitating immediate adjustments that maintain product quality and consistency, vital for brand reputation in a competitive market. Insights gained from these models inform the design of next-generation peeling machines, allowing for the development of more sophisticated mechanisms that adapt to various produce types, thereby optimizing space and resource utilization. Furthermore, modeling and simulation serve as valuable educational tools for training operators and engineers in the food processing sector, providing a visual understanding of the peeling process and its mechanics. This knowledge fosters better decision-making in real-world scenarios. As the food industry increasingly prioritizes sustainability, modeling techniques play a crucial role in developing eco-friendly peeling processes by optimizing energy consumption and reducing waste, aligning with global efforts to minimize environmental impacts. By leveraging these advanced techniques, manufacturers can achieve significant improvements in their peeling processes, leading to better products and a more sustainable food supply chain.

1.2 Methodology

The methodology adopted in this study is based on a qualitative–analytical review of peer-reviewed literature on modeling and simulation of peeling processes. The unit of analysis in this research is the modeling framework applied to peeling operations, specifically analytical models, kinematic models, finite element models, and molecular dynamics models. Each modeling framework is analyzed in terms of its theoretical basis, assumptions, computational requirements, and applicability to food peeling processes.

The units of observation consist of reported process parameters and performance indicators extracted from the reviewed studies. These include peeling force, peeling energy, feed rate, tool geometry, temperature distribution, stress–strain response, surface integrity, and material



removal mechanisms. Observations were drawn from simulation outputs and, where available, corresponding experimental or industrial validation results reported in the literature.

This structured distinction between units of analysis and observation enables systematic comparison across modeling approaches and supports consistent evaluation of their effectiveness, accuracy, and scalability for real-world food processing applications.

2.0 Fundamental Analytical Approaches

The analytical modeling and simulation of peeling processes have been the subject of recent research. In order to simulate the separation of an elastic membrane from a substrate, Liprandi et al. (2020) created a theoretical-numerical method that used a 3D cohesive law. This methodology emphasized the significance of the peeling line in maximizing adhesion. Grill et al.'s (2019) research on the separation of elastic adhesive fibers highlighted the complex nonlinear behavior resulting from adhesion, resistance to deformation, and mechanical contact interaction. A theoretical framework for the peeling of elastic tape off a substrate was presented by Begley et al. (2013). It took into account significant deformations and interfacial shear tractions during sliding. Using a Bernoulli-Euler beam theory for viscoelastic materials, Gao and Su (2015) investigated the peeling of a thin film adhesively bound to a stiff substrate and derived closed-form solutions for mode I and mode II loading scenarios. Ajeloua and colleagues (2021) performed a numerical simulation of the peel test on a ceramic substrate for ductile thin films. In their experiment, they examined peeling angle and residual thermal stresses in relation to crack formation in the ceramic substrate. The results indicate that the peeling phenomenon is a fracture mixed mode in which the peeling angle determines the relative dominance of either mode I or mode II set up in the model, while thermal residual stresses play a major role in thin film delamination. An analytical model and experimental verification of the interfacial peeling strength of electrodes were conducted by Huang et al. in 2021. To estimate the Young's Modulus and interfacial peeling strengths of the electrodes at various States of Charge (SOC), a uniaxial tensile test and a 180-degree peeling test were executed. With SOC, the energy balance released, and a decrease in peeling angle, the electrode's interfacial peeling strength increases.

Numerical models which are inferably obtained following interrelationships between fundamental physical quantities can be solved using fundamental analytical technique (Sun et al. 2019). Based on the process knowledge and choice of an adequate physical variables, physical model can be established through theoretical expressions. In view of this, workpiece interaction with the coarse tool is vital (Pratap & Patra, 2022). The interaction of the workpiece shows the impact of the material and the process of removal based on the system tribological properties (Orgeldinger et al. 2023). The peeling process represents the summation of interactions and the need for models capable of describing the complex interaction between the peeling tool topography, characteristics of workpiece and the process kinematics. This is in line with work done by Torta et al. 2020, who carried out a surface morphology predictive models for carrying out milling operations.

Peeling process kinematics can also be established through peeling tool topography and peel model thickness (Gu et al. 2016). A model of the force can then be established which can be adopted in determining coarse tools wear behavior and to determine the energy of peeling. The tool topography and models of peel thickness are employed in estimating the roughness of the surface. The peeling energy is essentially as a result of the superficial interfacial bond and dissipation area around the peeling interface (Zhang et al. 2022). Peeling modeling require a clear understanding on the surface adhesion to predict the active tool distribution and concentration



and its interaction with the surface of the workpiece (Gu et al. 2016). Combined and individual interactions that exist with the peeling knife and surface of workpiece will affect the system of peel formation process, and hence workpiece force of peeling and its surface finish. Most models requires a numerous pool of measurements to be carried out in estimating the parameters of the model. Also the process dynamic action and variation in tool geometry with time are not taken into cognizance.

Islam and Alfredsson 2019 used high peel displacement to study for scenarios where a compliant substrate will yield a high root rotational result. Present simplified models of beam was used to estimate the energy at fracture of peels which was eventually modified to cater for the foil kinematic beam model hardening. The steady-state force of peeling and the rotation of the root are the input data employed to the resulting theoretical model of the beam. Literature results were examined. An extensive finite element framework was equally examined, applying cohesive features for the linking surface within the substrate and the foil. The cohesive region variables utilized include shape parameter, cohesive strength and the fracture energy. Stéphane and Norishige, 2001 describes an intuitive approach for modeling the natural peeling condition over any 3D layer. Applying a cracked input information—precomputed with a semi-physical results—this approach simulates peeling on any type of triangulated 3-dimensional geometry. The system presents means of defining peeling groups, estimating a natural and realistic order of peeling, and means of simulating the rendering of two types of unique peelings. They presented a series of curling patterns and direct peeling through plastic-paintings simulated materials or classical paintings Ijiri et al., 2012 presented a robust and adequate framework for the simulation of the motion of cardiac beating. A robust cardiac motion was established through the gathering of myocardial fiber contractions at the local region. They computed a local-to-global deformations through a kinematic technique; divided a heart mesh model into overlapping local areas, independently contract them based on orientation of the fiber, and determined an overall geometry that governs contracted geometry of all local areas possibly. Comparisons between this approach and a physics-based technique revealed that this approach could initiate motion closely related to that of a physics-based simulations.

2.1 Peeling energy and forces

Accurate prediction of peeling force is important for the calculating workpiece and deformations of working tool and provided the thermal properties of the peeling system are to be monitored. Peeling strength, which is expressed as the products of the cutting speed and tangential forces could be utilized in estimating the needed peeling energy for peel generation. Most inputs in mechanical energy is converted into heats that is dispersed into the work piece, peel, tool, and working fluids, while the rest is utilized for generation of residual and surface stresses formation. Different peeling energy models (Popov et al., 2017; Popova and Popov, 2018; Li et al, 2018) have been published. The specific energy rises with decrease in thickness of penetration as the depth of the peel reduces. Variation in the peeling operations and the condition of dressing will affect the size of chips and consequently the specific energy of peeling.

A blend of low depth of penetration and cutting speed yields an increase in exact energy. This behavior could be utilized for a conditioned work hardening of the subsurface (Ren et al., 2016 & Xu et al. 2021). Bourscheid et al, 2024 investigated the effects of log infeed position and chipper-canter cutterhead diameter on the energy consumption and maximum power during processing of black spruce logs. The study evaluated how cutting speed (CS) and feed-per-knife (FK) affect the surface quality of black spruce cants processed by a chipper-canter. Results indicated that



lower FK improved surface quality, while higher CS enhanced waviness. Additionally, lower surface quality was observed in the cant's lower half, influenced by knots and grain orientation.

2.2 Thermal models

Anna et al., 2014 numerically simulated the heating of green wood logs by infrared (IR) radiation for veneer production peeling, focus was on the kinetics of heating a green wood cylinder which rotates as the radius decreases. Developed model merges the variables of green wood which includes density, moisture content, dispensation and ratio of latewood and earlywood, on one side, and conditions of peeling speed and veneer depth, on the other side. Consideration was given to the following heat transfer processes as shown in Figure 1: heating externally by the infrared source, conduction within the bolt and convection between the bolt surface and the external environment. Vidyarthi et al, 2020 observed the consequence of lye peeling and infrared technique on viscoelastic characteristics of tomato peels of varieties - Seminis HP 849, Hz 5508 and Seminis DRI 319 through a dynamic mechanical analyzer (DMA) in a temperature ramp condition. Peels were generated through infrared (IR) peeling investigated. Lye peeling was examined at 95 °C using a 10% solution of sodium hydroxide and at three tomato surface temperatures of 109, 112 and 115 °C, respectively. Fresh peels of tomatoes were utilized as a control. It was observed that all the peel samples dynamic moduli initially reduces and then increases as the temperature, displays a parabolic curve. Peel samples storage moduli was observed to be more than their respective loss moduli, showing a dominant elastic characteristics over viscous characteristics in tomato peels. Comparing with the control, lye treated peels and infrared had lower and higher moduli storage, respectively. Liu et al., 2023

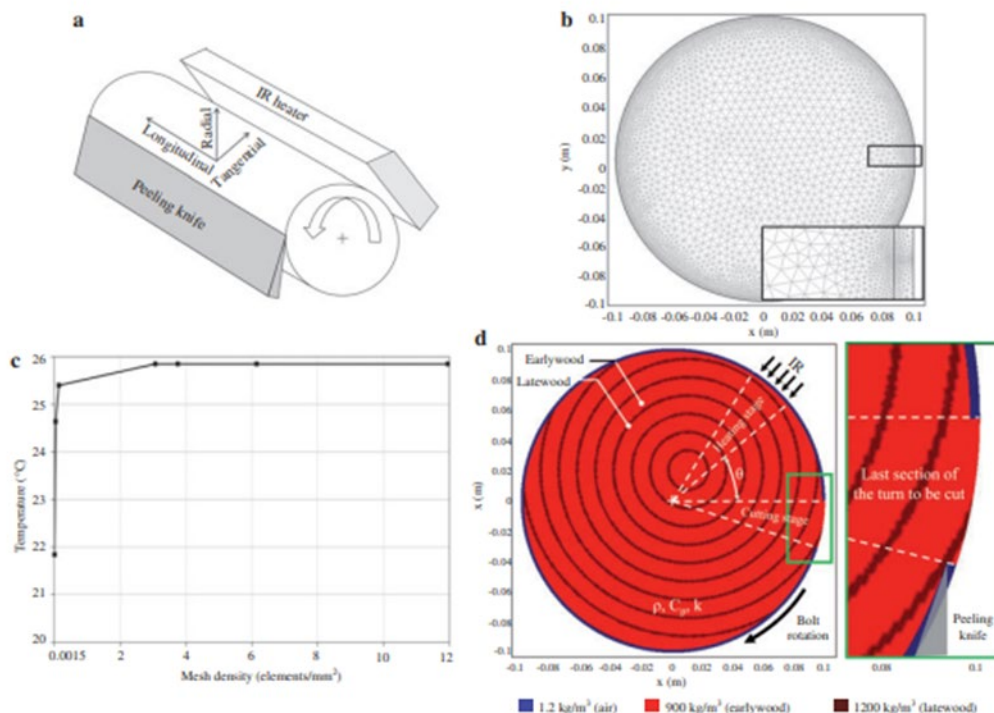


Figure 1: Infrared on-line heating of logs modeling for veneer manufacturing. (a) Surface heating principle, (b) finer mesh near the surface of the bolt, (c) Mesh-density refinement influence on results and (d) Surface layer removal modeling, when a bolt peeling is defined by



subdomain parametric settings (case of off-centered pith) – densities on display. (Source: Anna, et al., 2012)

A 3-D heat transfer model to predict the temperature of different positions on the surface and inside during the infrared peeling process of tomatoes, and by comparing the predictions of temperatures. The fitting degree of the model was confirmed by juxtaposing the measured value with the two different infrared devices. This was compared and analyzed through the energy consumption calculation, and the better infrared device was selected. Obtained results showed that, compared with the static catalytic infrared device, the gas-roller transmission catalytic infrared device can achieve rapid heating of the tomato skin (the maximum surface temperature is 60.32 °C), and temperature distribution on the tomato surface is more uniform having a maximum temperature difference is about 6.44 °C.

3.0 Kinematic Models in Peeling

The view today is that previous advances in kinematic process modelling in the early 1970s and 1960s have led to a basic 2-D description of processes. More complex kinematic models have been established from 1980ies upward due to the advent of faster computers.

Significant of the approaches is the 3-D perspective of the peeling operation through geometry penetration in the surface of workpiece and the cutting tool surface. Slight sophisticated approach to such models is the kinematic – empirical model. Were the output variables of the peeling system can be estimated by employing empirical and theoretical approach.

3.1 Fundamental kinematic techniques

Fundamental kinematic techniques play a crucial role in modeling peeling operations, primarily by providing insights into the interaction between the peeling tool and the workpiece. These techniques are rooted in the principles of motion and geometry, allowing for the analysis of various parameters that influence the efficiency and effectiveness of the peeling process.

Historically, early kinematic models were predominantly applied to grinding processes, utilizing two-dimensional grain models to describe the interactions between the cutting tool and the workpiece surface (Adibi et al. 2022 and Li et al. 2025). These models focused on determining crucial parameters such as cross-sectional topology, workpiece roughness, and the depth of peel. However, as computational capabilities have advanced, the field has shifted towards more complex three-dimensional kinematic models that can better represent real-world peeling operations. A key aspect of these fundamental techniques is the modeling of the peeling tool's trajectory and its interaction with the workpiece (Huang & Yan 2023). As shown in Figure 2, by employing coordinate transformation and matrix formulations, these models can accurately predict the new surface profile of the workpiece after peeling. This ability to simulate surface changes is vital for understanding the resulting material behavior and surface integrity. Moreover, kinematic models help identify the optimal peeling conditions, such as the angle and speed of the tool (Khadka et al. 2025). Understanding these variables allows manufacturers to fine-tune their peeling operations, minimizing waste and maximizing the yield of edible product. For example, empirical equations can be integrated into kinematic models to estimate output variables based on input parameters, enhancing the predictive capability of the models (Cui et al. 2020). Despite their strengths, fundamental kinematic techniques also have limitations. They often assume ideal conditions, neglecting factors such as tool wear, material variability, and dynamic interactions that occur during peeling. Future research should focus on developing more sophisticated kinematic models that incorporate these complexities, potentially leveraging advancements in computational power and real-time data analysis.

Hence, fundamental kinematic techniques are integral to the effective modeling of peeling operations. By providing a framework for analyzing the interactions between tools and workpieces, these techniques pave the way for improved efficiency and product quality in the food



processing industry. Continued advancements in this area will lead to more robust models that can better reflect the realities of industrial peeling processes.

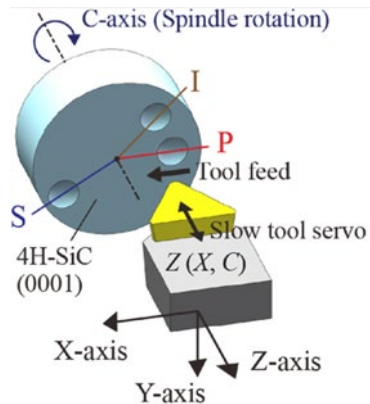


Figure 2: Mechanism for material removal

Source: Hunag and Yen 2023.

3.2 Discussion and Future Trend

The application of kinematic models in peeling processes has advanced significantly; however, several limitations persist that warrant further exploration and refinement. One primary challenge is the reliance on simplified assumptions regarding material behavior and tool interactions. Many existing kinematic models neglect the complexities of real-world conditions, such as varying material properties under different temperatures or the effects of tool wear over time. This simplification can lead to inaccuracies in predicting peeling forces and efficiencies. Future research should aim to develop more sophisticated kinematic models that incorporate adaptive algorithms capable of adjusting to dynamic conditions, thereby enhancing predictive accuracy. Additionally, integrating real-time monitoring systems with kinematic models could significantly improve their applicability. The ability to adjust models based on live data from peeling operations would allow for more accurate predictions and operational decisions.

Another critical area for exploration within kinematic modeling is the thermal effects during peeling operations. Current models often overlook the thermal dynamics that can significantly influence material behavior and peeling efficiency. Future work should investigate the coupling of thermal models with kinematic simulations to provide a more holistic understanding of the peeling process.

4.0 Finite Element Models

Adequate application of peeling operation requires an understanding and control of physical operational parameters such as temperature, forces, and peeling energy is very important as applied to grinding (Weinert and Schulte, 2003). Although the kinematic framework could be utilized as a means to eventually estimate forces and peeling energy, physical operational parameter model is definitely in the context of Finite Element Model, FEM. Finite Element Analysis (FEA) software can generate different result, i.e., strain, stress and distribution of deformation, based on user examination parameters and nature of the problem. Such results are described in Figure 3, where the distribution of stress of a FEA arterial model is illustrated in which the stress distribution for the plaque and arterial component under stent deployment is illustrated.

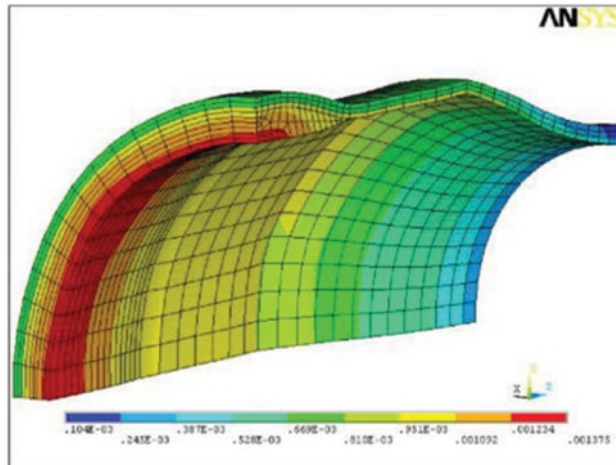


Figure 3: Plaque and arterial stresses under stent deployment where each layer illustrates various types of tissue.

Source: David et al., 2004

4.1 Finite Element Analysis Basics

The Lamé's elasticity theory derivatives is an example of differential equation which describes physical processes. For these models, numerical approach which include FEA or Finite Differential Method (FDM) are employed. In both, FEA and FDM, the actual process is changed into finite elements model. These finite elements are linked together by element nodes. The concerned area in the FDM is first splitted into a lattice structure.

Partial differential problems are solved by the accumulation of some sets of system of equations by substituting the differential quotients by the difference quotients with the lattice point practical results. One limitation is the difficulty in applying FDM for geometries which are intricate. Another limitation is that a lattice structure refinement in its local region is impossible, the refinement of the whole structure can be accomplished. The FDM can be a viable resources for specific problems in determining the conduction of heat in peeling as applied in grinding (Starostin and Kondakov, 2003)

The so-called "shape functions" or "interpolation functions" are used in the FEA to find the differential equations, producing a system of linear equations. Moreso the mechanical load, thermal and workpiece properties must be available. The stiffness is dependent on the workpiece geometry and the material properties. A limitation of the FEA is the likelihood in generating complex structural irregular meshes. Locally, the mesh can also be adopted, which is particularly important for frameworks that are large.

Usually, FEA models for the simulating peeling operations can be divided into microscopic and macroscopic approach. However, macroscopic simulation is applied in most cases so as to estimate the impacts of mechanical surface pressure and heat on the whole workpiece based on the form deviation or temperature distribution. The solutions are majorly based on elasto-mechanical and thermomechanical material properties. The peel formation and plastic material behavior are not given consideration.

As a divergence from that, the microscopic simulations are confined to working zone analysis. Hence, mainly few section of the workpiece and contact point of the cutting tool teeth is modeled. Till date, the most comprehensive technique for simulating peeling operation is microscopic approach. An elasto-plastic material behavior is examined and also formation of chip for a realistic simulation. There is need to know the actual behavior of material for high strain rates. Moreso, recent computer power is insufficient to generate a detailed model of a complete peeling tool in



simulations which are microscopic in nature or to contemplate the development of chips in macroscopic simulations (Klocke, 2003). To transmit a peeling operation into a simulated settings, a drop in the system parameters is important. In this ideal framework, there is integration of all needed process variables, boundary and transition and boundary conditions. The input variables for a typical Finite Element Analysis simulation include: workpiece geometry, material properties of the workpiece, peeling forces, processing condition, the coefficient of heat transfer between workpiece and cooling lubricants, boundary and cooling conditions.

In several macroscopic models the peeling tool is described by a combination of the surface pressure and heat source, which moved over the workpiece surface at a defined speed of operation. The circulation of the actual heat source inside the region of contact, between the workpiece and the peeling tool, must be established so as to generate a holistic input variables, most especially the distribution of heat flux (Schnieder, 1999).

4.2 Review of Works Done

Various contributions as well as researches has been done as regarding enhancing peeling processes using Modeling and simulation. Process models have been developed using FEA (Finite Element Analysis).

Crocombe and R.D. Adams, 1981 investigated the adhesive peel test using significant displacement finite element analysis and then experimental investigation; only elastic behavior has been taken into consideration thus far. Both cracked and non-cracked arrangements were analysed, representing initial and continuous failure of the peel test. The adhesive principle stresses forcing a fracture toward the point of contact that connects the flexible adherend were the initial cause of failure, according to analysis of the former. The quantity of mode II loading at the crack tip is substantial and virtually irrespective of peel angle, load, and adhesive or adherend modulus, only diminishing as the adhesion becomes incompressible, according to research on the cracked configuration. It has been demonstrated that failure (propagation), regardless of peel angle, happens at a crucial applied bending moment for a specific adherend and adhesive. Additionally, the strength (load) determined by the peel test is not proportionate to the adhesive's true strength; a slight increase in adhesive strength results in a far greater increase in the applied peel load. The test was investigated using subsequent experimental work and large displacement finite element analysis; only elastic behavior was considered.

Vishal et al., 2013 researched into the finite element method (FEM) and its application. They gave details on discretization, numerical analysis and approximate solutions as regarding Finite element methods. Kumara et al., 2012 investigated turning process as a metal cutting operation, by modeling and simulating turning operations. Using the FEM to simulate the metal cutting process is one of the cutting-edge initiatives in manufacturing engineering. The amount of trials can be decreased and the cutting process better understood through simulation. This study uses a FEM model to evaluate the metal cutting process in order to simulate the turning process in three dimensions using a solid single point cutting tool. This utility uses CATIAV5 for modeling, exports STL files, then imports them into DEFORM 3D. Yanniotis, 2000 also carried out an analytical study on the rate of heat transfer during food processing to provide ideal processing conditions and the necessary machinery. An analytical method was utilized in the study. Mohammed et al. 2016 used Finite Element (FE) peeling simulations approach to model the influence of feed rate and tack of pressure-sensitive adhesives and geometry on peeling. They reported on a novelty approach to solve parameter calibration problem posed by cohesive zone method of peeling. Peel tests were examined at various rates using samples made from a backing membrane made from polyester supported by pressure sensitive adhesive (PSA) made from an acrylic. The influence of test rate and PSA thickness on both peel and tack was modeled numerically, as well as experimentally. There was good agreement between the numerically



predicted and experimentally measured peel forces. Additionally, it was observed that the rate dependence detected in the probe-tack data and peel was subjugated by the rate dependence of the interfacial properties.

Desai et al. (2018) evaluated residual stress caused by metal cutting numerically. This study employs the finite Element Method (FEM) simulation to examine how tool shape and cutting parameters affect residual stress in orthogonal machining of aluminum 1100-0. Ansys Workbench was used to do explicit dynamics analysis. The findings show how residual stress varies with tool geometry, depth of cut, nose, and machining speed. The findings show how the aforementioned parameters and residual stress are related.

More also, Mohammadpour et al., 2010 carried out a study, and the current study's goal was to create a finite element analysis using the nonlinear finite element code MSC. Super form for examining the impact of feed rate and cutting speed on residual stresses caused by orthogonal cutting on the surface and subsurface. The current study is essentially a coupled dynamic-transient thermo-mechanical problem. When compared to experimental measurements of orthogonal cutting of steel AISI 1045 that are available in the literature, the model's results show good agreement with the experimental data.

Residual Stresses in machining was studied by Proudian, 2012 beginning from post-process measurement down to pre-process predictions with the aid of Finite Element Analysis. Using the commercial program DEFORM, the author studied, modeled, and simulated orthogonal metal cutting using the finite element approach. Simulations of orthogonal cutting of 20NiCrMo5 steel are carried out, and the outcomes of the simulations are verified using experimental data. Variations in the feed rate, cutting speed, and rake angle are examined and evaluated in relation to the produced residual stress. The findings of the simulation provide information about how cutting settings and tool geometry affect the residual stresses that are induced. Cutting speed and rake angle exhibited a trend when changing the parameters on the created residual stress, according to the simulation results.

Maryam, 2014 also developed and validated Finite Element Analysis (FEA) modeling techniques are used to create a computational model of the mechanical peeling process of tough-skinned vegetables. In order to accomplish this, a number of experiments were conducted on peeled, unpeeled, and meat samples of pumpkin, including uniaxial compression, indentation, and tensile testing. Additionally, some of the necessary physical characteristics of the peel and flesh samples were determined through experimentation. Additionally, the cellular alterations of tissues before and after mechanical loading procedures were recorded using a Scanning Electron Microscopy (SEM) apparatus. A compatible constitutive theory for the non-linear mechanical response of pumpkin peel and flesh samples under significant deformation was chosen and validated using the experimental results. Compressive test was also carried out on cassava stems and FEA packages were used to perform analysis in order to determine stress and other parameters useful for designing peeling machines. This study was done by Zhang et al., 2016 Cassava stems were subjected to compressive tests using a universal testing equipment to ascertain their compressive strength limitations, or the points at which the stems started to undergo plastic deformation. The mechanical models of the cassava stems were built using ANSYS, a universal finite element analysis (FEA) program, based on the test, and the displacements, stresses, and shear stresses inside the stems as they fractured under compressive loads were examined.

Extra efforts were then made by Tian et al., (2017) in reducing mechanical damage to Kiwifruit during picking, peeling, packaging and even transportation. The mechanical characteristics of kiwifruit peel, flesh, and placenta were examined using a universal testing equipment in order to lessen the mechanical damage that occurs during the harvesting, packing, and transportation processes as well as to comprehend the mechanism of kiwifruit damage. The average elastic



modulus, tensile strength, and tensile force of the radial and axial tensile of kiwifruit peel were determined to be 12.04 MPa, 1.26 MPa, 5.27 N and 12.85 MPa, 1.21 MPa, 5.28 N, respectively. Additionally, the average elastic modulus, tensile strength, and tensile force of the axial and radial compression of kiwifruit flesh were tested; these values include 3.96, 0.70, 0.42, and 1.71, 0.45, and 0.33 MPa, respectively. Additionally, the mean modulus of elasticity, tensile force, and tensile strength, of the radial and axial compression of kiwifruit flesh were found to be 5.33, 2.24, 1.63, and 4.32, 1.75, 1.54 MPa, respectively. The finite element model of the kiwifruit was created using the geometric structure and mechanical characteristics of its constituent parts. Workbench ANSYS software was used to simulate and analyze the stress scattering and variation rule of the entire fruit under compressive force. The findings demonstrated that the stress at the contact region between the placenta of the kiwifruit and the seed chamber initially approaches its stress yield limit when the fruit was subjected to continuous radial compression and the compressive strain reached 0.060, and the stress in the end region of the placenta first reached the yield stress limit when the kiwifruit was subjected to axial compression and the compressive strain reached 0.068. Lastly, a plate compression test was used to test the entire kiwi fruit. The results demonstrated that the finite element simulation for kiwifruit was feasible and that the stress-strain curves of the entire fruit's finite element simulation and actual compression were identical under various compressive directions. Ravichandran, 2020 performed a study on the computational technique for solving boundary problems and nonlinear differential problems. He explained how ANSYS could be used to analyze weld thermal cycle. Jin et al., 2003 presented an effective finite element analysis method utilizing mesh superposition. The technique was formulated for both two-field assumed strain finite element models and single-field assumed displacement finite element models. The global mesh for the area of interest is superimposed with the refined local mesh. This adaptive mesh refinement technique permits local mesh refining without the need for multi-point constraints or transition regions. Inter-element compatibility requirements can be met and singularity in the global stiffness matrix can be prevented by imposing suitable boundary constraints on the local overlay mesh. Numerical examples of dynamic, linear static, and buckling elasticity problems are used to illustrate the efficiency of the current technique. Additionally, the efficacy of the current process was evaluated for issues including distorted grids and curved geometries. Additionally, different solutions schemes are examined for efficient analysis using the current approach.

4.3 Discussion and Future Trends

Finite element models have proven effective in simulating the mechanical behavior of materials during peeling; however, they face challenges related to computational intensity and the need for high-quality mesh generation. Complex geometries and material behaviors under high strain rates can complicate simulations, making real-time application difficult. To address these issues, research should focus on developing hybrid modeling approaches that combine finite element analysis with machine learning techniques. Such integration could allow for faster computations and more accurate predictions by training models on empirical data. Furthermore, finite element models currently lack comprehensive integration with real-time monitoring systems, similar to kinematic models. The ability to adjust these models based on live operational data could significantly enhance their effectiveness. Future studies should explore the integration of Internet of Things (IoT) technologies with finite element modeling frameworks to facilitate data-driven decision-making in peeling processes. Lastly, as sustainability becomes increasingly important in food processing, finite element models should account for environmental impacts, such as energy consumption and waste generation. By integrating sustainability metrics into modeling



frameworks, researchers can better evaluate the ecological footprint of various peeling processes and contribute to the development of greener practices.

5.0 Molecular Dynamic Models

Simulations involving Molecular Dynamics (MD) through atomic frameworks have gained attention in order to have an accurate knowledge of material behaviors at the microscopic level and structure have been employed in studying different properties of materials and phenomena covering solids, liquid and gases (Hoover, 2012).

5.1 Advances in MD-modeling of peeling

Molecular Dynamics (MD) modeling has emerged as a powerful tool for understanding the microscopic behavior of materials during peeling operations. By simulating atomic interactions, MD provides a detailed insight into the physical processes governing material removal, adhesion, and delamination at the nanoscale (Choi, 2023). This approach allows researchers to explore phenomena that are often difficult to observe experimentally, thereby enhancing the understanding of peeling mechanics.

Recent advancements in MD modeling have focused on developing comprehensive material descriptions that account for microstructure, chemical composition, and atomic interactions. These models transcend traditional single-crystalline assumptions, enabling the study of complex behaviors in polycrystalline materials and those with defect structures. For instance, studies have shown that the mechanical behavior of materials, which include their adhesion strength and peeling behavior, could vary significantly as a result of their atomic arrangement and environmental interactions. One notable application of MD modeling in peeling is the investigation of the adhesion and peeling of nanoscale materials, such as thin films and biological tissues. Recent research has demonstrated that the critical peel-off force can depend not only on the peeling angle but also on the elasticity of the material being peeled. Such insights are invaluable for industries that rely on precise peeling techniques, such as electronics manufacturing and food processing. Moreover, advances in computational power have enabled the simulation of larger systems over longer time scales, allowing for more realistic modeling of peeling processes. For example, recent MD simulations have successfully modeled the peeling of DNA molecules from surfaces, providing insights into the interactions that govern adhesion at the molecular level. These findings have implications for fields ranging from nanotechnology to biomedical engineering. Despite these advancements, challenges remain in MD modeling of peeling processes. Current simulations often operate under idealized conditions that may not fully represent the complexities encountered in practical applications. Future research should aim to enhance MD models by incorporating fluid dynamics to simulate environmental effects, such as moisture or temperature variations, which can influence peeling behavior. Additionally, integrating MD simulations with finite element modeling could facilitate a multi-scale approach that combines atomic-level insights with macroscopic behavior, leading to more comprehensive predictions of peeling performance.

5.2 Discussion and future trends

Molecular Dynamics (MD) modeling has significantly advanced the understanding of peeling processes at the atomic level, yet several challenges remain that require further research and innovation. One of the primary limitations of current MD models is their reliance on idealized conditions, which may not accurately reflect the complexities found in real-world peeling operations. For instance, many simulations assume a uniform environment, neglecting the influence of factors such as temperature fluctuations, humidity, and material imperfections, which

can substantially influence adhesion and peeling behavior. To enhance the applicability of MD modeling, future research should focus on developing more robust models that incorporate these environmental variables. By simulating realistic conditions, researchers can gain deeper insights into how these factors affect the peeling process. Additionally, integrating MD simulations with experimental data could help validate models and refine predictions, leading to greater accuracy and reliability in practical applications.

Another promising avenue for future exploration is the integration of MD modeling with other computational techniques, such as finite element analysis (FEA) and continuum mechanics. This multi-scale approach would allow for a comprehensive analysis that captures both atomic-level interactions and macroscopic material behavior. By combining the strengths of MD and FEA, researchers can create more detailed models that account for the complexities of peeling, including the influence of tool geometry, material behavior, and dynamic loading conditions. Moreover, the extension of MD models to include fluid dynamics could give valuable insights into the role of lubrication and cooling during peeling operations. Understanding how fluids interact with surfaces at the molecular level can inform the design of more effective peeling processes, especially in applications where heat generation and friction are significant concerns.

As sustainability continues to be a priority in the food processing and materials industries, future MD research should also focus on evaluating the environmental impacts of peeling processes. By incorporating sustainability metrics into MD modeling frameworks, researchers can assess the energy consumption and waste generation associated with various peeling techniques, ultimately guiding the development of greener practices. Figure 4 shows the simulation model used for the Cold Gas Dynamic Spraying (CGDS) deposition technique so as to create an ultra-thin palladium foil with a molecular dynamic (MD) simulation technique on a copper substrate surface

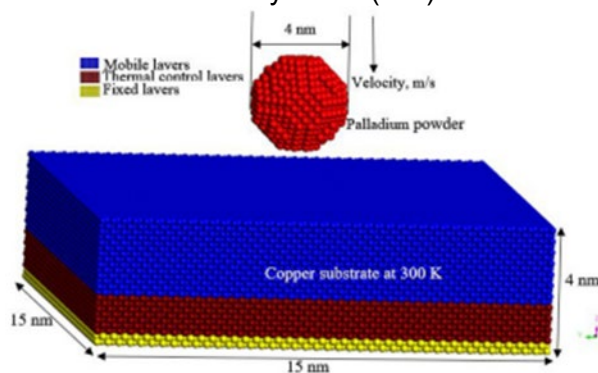


Figure 4: Schematic model for Molecular dynamics simulation.

Source: Oyino et al., 2020

6.0 Model Validation and Experimental Correlation

To enhance the reliability and applicability of the modeling and simulation approaches reviewed in this study, model validation was considered through comparison with reported experimental findings in the literature. Validation is a critical step in ensuring that analytical, kinematic, finite element, and molecular dynamics models accurately represent real peeling phenomena encountered in food processing operations.

For analytical and kinematic models, validation is commonly achieved by correlating predicted peeling forces, energy consumption, and surface roughness with experimental measurements obtained from controlled peeling tests (Brightwood et al. 2024). Several studies reviewed in this work reported close agreement between simulated and experimental results, particularly in predicting trends associated with variations in feed rate, cutting speed, and tool geometry. Such



correlations confirm the suitability of simplified analytical and kinematic formulations for preliminary design and process optimization.

Finite element models are typically validated by comparing simulated stress–strain responses, deformation patterns, and peeling forces with laboratory experiments conducted on food materials or their mechanical analogues (Słupska et al. 2026). Prior studies reviewed demonstrated good agreement between FEM predictions and experimental data, especially when elasto-plastic material behavior and appropriate boundary conditions were incorporated. This agreement supports the use of FEM as a robust tool for evaluating tool–workpiece interaction, residual stresses, and thermal effects during peeling (Lang et al. 2022).

At the molecular scale, molecular dynamics models are validated through consistency with experimentally observed adhesion energies, peeling forces, and failure mechanisms reported in nanoscale or thin-film peeling studies (Yuan et al. 2024). Although direct experimental validation at the atomic scale remains challenging, MD simulations provide valuable qualitative and quantitative insights that complement continuum-scale models.

Overall, the convergence between simulation results and experimental observations reported across the literature reinforces the credibility of the reviewed modeling approaches and highlights their suitability for guiding the design and optimization of peeling processes in industrial food processing. Table 1 describes the modeling approaches, units of analysis and practical output in industrial application.

Table 1: Summary of Modeling Approaches, Units of Analysis, and Practical Outputs

Modeling Approach	Unit of Analysis	Units of Observation	Typical Validation Method	Practical Industrial Outputs
Analytical Models	Governing equations describing peeling mechanics	Peeling force, peeling energy, peel thickness	Comparison with simplified experimental peeling tests	Rapid estimation of force and energy requirements; early-stage process design
Kinematic Models	Tool–workpiece motion and geometric interaction	Surface roughness, peel geometry, material removal rate	Correlation with measured surface profiles and peeling trajectories	Optimization of tool angle, feed rate, and peeling speed
Finite Element Models (FEM)	Continuum mechanical and thermal behavior	Stress–strain distribution, deformation, temperature fields	Experimental force–displacement and thermal measurements	Tool design optimization, energy efficiency improvement, durability assessment



**Molecular
Dynamics
(MD) Models**

Atomic-
scale
material
and
adhesion
interactions

Adhesion energy,
atomic
displacement, failure
initiation

Consistency
with nanoscale
experimental
trends and
literature

Insight into adhesion
mechanisms and
surface interaction at
micro/nano scales

Modeling Approach	Unit of Analysis	Units of Observation	Typical	Validation	Method
Practical Industrial Outputs					
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Kinematic Models	Tool–workpiece motion and geometric interaction	Surface roughness, peel geometry, material removal rate	Correlation with measured surface profiles and peeling trajectories	Optimization of tool angle, feed rate, and peeling speed	
Finite Element Models (FEM)	Continuum mechanical and thermal behavior	Stress–strain distribution, deformation, temperature fields	Experimental force–displacement and thermal measurements	Tool design optimization, energy efficiency improvement, durability assessment	
Molecular Dynamics (MD) Models	Atomic-scale material and adhesion interactions	Adhesion energy, atomic displacement, failure initiation	Consistency with nanoscale experimental trends and literature	Insight into adhesion mechanisms and surface interaction at micro/nano scales	

7.0 Real-World Implications and Economic Impact of Modeling-Driven Peeling Optimization

The reviewed modeling and simulation approaches demonstrate strong potential for translating theoretical insights into practical improvements in food peeling operations. In real-world industrial settings, peeling represents a critical cost and quality control stage, particularly for high-volume processing of fruits and tubers (Zhou et al. 2022; Saroj et al. 2025). Even marginal improvements in peeling efficiency can lead to substantial economic gains when scaled across continuous production lines (FasterCapital, 2025). Modeling-driven optimization enables processors to determine optimal combinations of tool geometry, peeling speed, feed rate, and thermal conditions, thereby reducing unnecessary removal of edible material and increasing usable yield (Zhujani et al. 2025) as shown in Table 2.

From an economic standpoint, reduced peel loss directly translates into higher product recovery rates and improved profitability (Kholi et al. 2021). Studies reviewed indicate that optimized peeling conditions can significantly lower raw material waste, which is particularly impactful for high-value produce such as tomatoes, kiwifruit, tomatoes, mandarin, cassava, and avocados (Jang et al. 2022; Metalo, 2023). Additionally, predictive models help minimize trial-and-error experimentation during equipment setup and process tuning, leading to reduced development costs and faster deployment of new peeling systems (Ahady et al. 2023; Zubair et al. 2024). This is especially beneficial for small- and medium-scale processors who often operate under tight economic constraints.

Energy consumption constitutes another major cost driver in industrial peeling operations (Goffin et al. 2024). Thermal and finite element models reviewed in this study provide valuable insights into heat generation, dissipation, and energy efficiency during peeling. By optimizing thermal input



and mechanical loading, processors can reduce excessive energy use while maintaining or improving peeling performance. Such reductions not only lower operational costs but also contribute to decreased greenhouse gas emissions, aligning economic objectives with environmental sustainability goals.

The industrial relevance of these modeling approaches also extends to equipment durability and maintenance planning. Accurate prediction of peeling forces and stress distributions enables better tool material selection and design, resulting in longer tool life and reduced downtime (Wang et al. 2025). Lower maintenance frequency and extended service intervals further reduce production interruptions and labor costs, thereby improving overall equipment effectiveness (OEE).

At the policy and strategic planning level, modeling and simulation provide evidence-based support for decision-making in sustainable food processing (Longo et al. 2025; George et al. 2023). The ability to quantify efficiency improvements, waste reduction, and energy savings allows stakeholders to evaluate the economic feasibility of adopting advanced peeling technologies. Policymakers can leverage such data to incentivize investment in energy-efficient and low-waste processing equipment through subsidies, standards, or regulatory frameworks that promote sustainable industrial practices. Furthermore, the generalizability of the reviewed modeling frameworks enhances their real-world applicability across diverse food products and processing scales. Because the underlying principles are based on fundamental mechanics, thermodynamics, and material behavior, these models can be adapted to different crops, machine configurations, and regional processing conditions. This adaptability supports technology transfer from research environments to industrial application, particularly in developing economies where resource efficiency is critical.

Overall, the integration of modeling and simulation into industrial peeling operations offers a pathway to achieving economically viable, environmentally sustainable, and technologically advanced food processing systems. Continued development of hybrid models that incorporate real-time sensor data, machine learning, and economic performance indicators will further strengthen the role of simulation-based optimization in meeting both industrial competitiveness and sustainability objectives.

Table 2: Indicative Economic and Sustainability Impacts of Modeling-Based Peeling Optimization

Performance Indicator	Typical Industrial Baseline	Indicative Improvement Range (from literature)	Economic and Sustainability Implications
Raw material yield	75–95% usable product	+3–15% yield improvement	Reduced raw material waste; higher revenue per unit input
Peeling energy consumption	High energy demand in thermal/mechanical peeling	5–20% energy reduction	Lower operating costs; reduced carbon footprint
Tool wear rate	Frequent replacement due to high stresses	10–30% increase in tool life	Reduced maintenance cost and downtime



Process development time	Trial-and-error based setup	20–40% reduction	Faster commissioning; lower capital and testing costs
Overall equipment effectiveness (OEE)	Dependent on downtime and variability	2–8% improvement	Improved productivity and throughput
Environmental impact	High waste and energy intensity	Single- to double-digit % reduction	Alignment with green manufacturing and SDGs

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8.0 Contributions and Generalizability of the Study

This study makes three primary contributions to the body of knowledge on modeling and simulation of peeling processes. First, it provides a consolidated and multi-scale synthesis of analytical, kinematic, finite element, and molecular dynamics models, highlighting how each framework contributes unique insights into peeling mechanics. Second, the study systematically links modeling outputs to practical process variables relevant to industrial food processing, including efficiency, waste reduction, and energy optimization. Third, it identifies methodological gaps and future research directions that can guide the development of more adaptive and data-driven peeling systems.

The findings of this review are generalizable across a wide range of food processing applications, as the modeling principles discussed are not crop-specific but are instead based on fundamental mechanical, thermal, and material interaction mechanisms. Consequently, the insights presented are applicable to diverse peeling contexts, including tubers, fruits, and vegetables with varying mechanical properties. Furthermore, the modeling approaches reviewed can be extended beyond food processing to related manufacturing and materials-handling industries, reinforcing their broader relevance.

9.0 Conclusion

This study set out to examine modeling and simulation techniques applied to peeling operations in food processing, with the objective of clarifying their theoretical foundations, methodological



rigor, and practical relevance. By systematically reviewing analytical, kinematic, finite element, and molecular dynamics models, the paper established a structured understanding of how peeling forces, energy consumption, thermal effects, and material behavior can be predicted and optimized across multiple modeling scales. The distinction between units of analysis (modeling frameworks) and units of observation (process parameters and performance indicators) further strengthens the methodological transparency of the study.

The findings demonstrate that validated modeling approaches—particularly those supported by experimental or empirical correlations—offer reliable tools for improving peeling efficiency and reducing material losses. From an industrial perspective, these improvements translate into tangible economic benefits, including higher product yield, reduced energy consumption, extended tool life, and lower operational costs. Such outcomes are especially significant for high-volume and high-value food processing operations, where even marginal efficiency gains can have substantial economic impact.

In the context of green and sustainable development, the reviewed modeling techniques support resource-efficient manufacturing by enabling waste minimization, energy optimization, and improved process control. The insights presented in this study can inform industrial best practices as well as policy initiatives aimed at promoting sustainable food processing technologies. Regulators and decision-makers may leverage model-based evidence to encourage adoption of energy-efficient equipment and environmentally responsible processing standards.

A key contribution of this work lies in its emphasis on generalizability. The modeling principles discussed are grounded in fundamental mechanical, thermal, and material interaction mechanisms and are therefore applicable across a wide range of food products and peeling conditions. As such, the conclusions drawn extend beyond specific case studies and offer transferable knowledge relevant to diverse food processing systems and related manufacturing domains.

Future research should focus on integrating real-time sensing, Internet of Things (IoT) technologies, and machine learning with established modeling frameworks to enable adaptive and intelligent peeling systems. Incorporating economic and environmental performance indicators directly into simulation models will further enhance their value for industrial decision-making. Overall, this study reinforces the critical role of validated modeling and simulation in advancing efficient, economically viable, and sustainable peeling operations in modern food processing industries.

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A Validated Model to Implement Green Initiatives at South African Universities

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Abstract

This article validates a model for implementing green initiatives at South African universities, taking into account the benefits and challenges that public universities may encounter. The study's objectives are to empirically validate the model's benefits and challenges in implementing green initiatives. A mixed-method approach was used and eight senior personnel at leading South African universities were interviewed to identify green initiatives, their challenges and benefits, and how these initiatives were implemented. The respondents also identified suitable measuring criteria. The quantitative analysis used a five-point Likert-scale questionnaire. These questionnaires were distributed online and via gatekeepers at the Human Resource Departments of the eight universities, as well as to other university managers and senior staff. A total of 144 completed questionnaires were received. The data are reliable ($\alpha = 0.843$), the sample is adequate ($KMO = 0.641$), and the results are significant ($p \leq 0.05$) at the 95% confidence level. Confirmatory factor analysis validated the model, and after discarding several criteria with low regression weights, the model fit is acceptable for exploratory research (normed and non-normed fit indices exceed the required 0.90). Only the Root Mean Square Estimated Error is marginally acceptable ($RMSEA = 0.10$). The model is a good fit and can be operationalised. As such, public university management can use the model as a managerial aid in implementing green initiatives.

Keywords: environmental practices, green initiatives, model, quantitative, South Africa, universities.

Introduction

Background

The increasing urgency of climate change and resource depletion has prompted higher education institutions (HEIs) globally to play a leading role in driving sustainable development (Chankseliani & McCowan, 2021). Universities are not only centres of knowledge production but also significant consumers of resources, generating substantial environmental footprints through energy use, waste generation, and transport emissions (Valls-Val & Bovea, 2021). In South Africa, universities face a dual challenge of aligning institutional operations with global sustainability goals while navigating the socio-economic realities of a developing nation (Mawonde & Togo, 2019; 2021). Several South African universities have launched green initiatives, such as renewable energy projects, recycling campaigns, and environmental education programmes. These efforts are often fragmented and lack coherent management frameworks, as well as a unified approach, which hinders long-term progress and measurement (Tshivase & Bisschoff, 2023a).



Problem Statement

South African universities are facing growing pressure to demonstrate their commitment to sustainability through their teaching, research, and operational practices (Mutinda & Liu, 2021). While many institutions have introduced environmental policies and green initiatives, the implementation and management of these efforts remain inconsistent and fragmented (Van Schalkwyk *et al.*, 2022). There is no unified model that enables universities to systematically measure, coordinate and evaluate their sustainability performance. As a result, green initiatives are often pursued in isolation, lacking the institutional support (Rubel *et al.*, 2025), accountability mechanisms (Li *et al.*, 2022), and performance indicators (Chininga *et al.*, 2024) necessary for long-term impact. Existing research suggests that perceptions of sustainability efforts differ between academic and administrative staff, presenting challenges in aligning objectives and ensuring effective collaboration (Goel *et al.*, 2022). Furthermore, barriers such as limited funding, inadequate leadership commitment and poor communication hinder progress (Tshivhase & Bisschoff, 2023a). Without a structured approach to managing green initiatives, universities risk undermining their sustainability goals and missing opportunities to lead by example in addressing national and global environmental challenges (Fissi *et al.*, 2021).

This study aims to address the need for a comprehensive model among South African universities to manage green initiatives sustainably on their campuses.

Research Objectives

The study's objectives are to empirically validate the model's benefits and challenges in implementing green initiatives.

1.4. Hypotheses

The following hypotheses were formulated for the study:

H₀: There is no significant relationships between *Barriers*, *Benefits* and *Implementation* at South African Universities.

H₁: There is a significant relationship between *Barriers* and *Benefits* at South African Universities.

H₂: There is a significant relationship between *Barriers* and *Implementation* at South African Universities.

H₃: There is a significant relationship between the *Benefits* and *Implementation* at South African Universities.

Literature Review

The literature review begins by examining the current state of green initiatives on South African university campuses. The literature study highlights the benefits that universities can reap from implementing green initiatives, while also identifying the barriers that prevent universities from doing so. Several factors drive universities' pursuit of green initiatives, while specific implementation factors determine their actual implementation.

2.1. Existing green initiatives



South African universities operate in a context marked by resource constraints, high energy costs and competing institutional priorities (Jansen, 2023). While the national policy framework, such as the Green Paper for Post-School Education and Training, emphasises sustainability, implementation remains inconsistent (Department of Higher Education and Training, 2024). HEIs like Stellenbosch University (SUN) (SUN, 2025), the University of Cape Town (UCT) (UCT, 2025), and the University of Pretoria (UP) (UP, 2025) have initiated solar energy projects and waste recycling schemes, but these are not yet fully integrated into institutional governance systems. Furthermore, smaller or rural universities often lack the financial capacity and technical expertise to implement large-scale green projects (Tshivhase & Bisschoff, 2023b).

The current situation can thus be characterised by:

- *Uneven institutional commitment:* Sustainability offices or policies exist at some universities but not all (Adams & Luiz, 2022).
- *Limited coordination:* Green efforts often depend on individual departments or external grants (Tshivhase & Bisschoff, 2024).
- *Weak monitoring mechanisms:* Success is seldom measured against key performance indicators (KPIs) (Shange *et al.*, 2025).
- *Cultural and behavioural inertia:* Staff and students may perceive green initiatives as peripheral rather than central to the university mission (Bisschoff & Tshivshe, 2023a).

This fragmented landscape underscores the need for a coherent management model that integrates green initiatives into institutional strategy and performance systems.

South African universities have made notable progress in several sustainability domains, including energy, water, waste and education. Examples include:

- *Renewable energy:* UCT (2025) and UP (2025) have installed solar photovoltaic systems to reduce reliance on the national grid.
- *Waste management:* SUN (2025) runs campus-wide recycling programmes and composting initiatives.
- *Water conservation:* UP (2025) implemented rainwater harvesting systems and greywater reuse during drought periods.
- *Sustainability education:* At Wits University, environmental studies are integrated into curricula at multiple institutions, promoting awareness among students (Wits University, 2025).

However, these initiatives often remain project-based rather than institutionally mainstreamed, as few universities have adopted comprehensive sustainability assessment tools. For instance, only Rhodes University employs a Unit-based Sustainability Assessment Tool that assesses the level of integration of sustainability into university functions (Rhodes University, 2025) or conducts internal carbon audits like UCT (2024). The proposed model in this study aims to consolidate such initiatives under a unified management framework that aligns strategy, implementation and measurement.



2.2. Determinants of Green Initiative Adoption in Higher Education Institutions

The successful adoption and implementation of green initiatives within universities is contingent upon a constellation of internal and external factors. These determinants operate across strategic, cultural, financial, regulatory, technological, and participatory domains, each exerting a distinct influence on institutional sustainability outcomes.

- *Leadership and Governance:* Effective sustainability governance is predicated on robust leadership commitment. Senior university executives play a pivotal role in embedding environmental objectives into institutional strategic frameworks and ensuring adequate resource allocation. Empirical evidence suggests that when sustainability is championed at the executive level, the likelihood of successful adoption increases markedly (Sippel & Visser, 2020).
- *Institutional Culture:* The prevailing institutional culture significantly shapes the trajectory of sustainability practices. A culture that prioritises accountability, innovation, and environmental stewardship, as reflected in the attitudes, values, and behaviours of academic and administrative staff, serves as a catalyst for widespread participation in green initiatives (Dalu et al., 2023).
- *Funding and Resource Availability:* Financial constraints are a critical barrier to implementing green infrastructure, particularly in the South African higher education context. Many institutions are heavily reliant on government subsidies and tuition fees, which limit their fiscal capacity to invest in sustainability-oriented capital projects (Moyo & McKenna, 2021).
- *Regulatory and Policy Environment:* The regulatory and policy landscape shapes institutional responses to environmental imperatives. While national policies and university mandates provide a framework for action, their effectiveness is often undermined by weak enforcement mechanisms and competing institutional priorities (Ngcamu & Mantzaris, 2023).
- *Technological Capacity:* Access to advanced, energy-efficient technologies and the requisite technical expertise is essential for the successful implementation of green initiatives. Technological readiness not only enhances operational efficiency but also scales up and amplifies the impact of sustainability interventions (Mbeki et al., 2025).
- *Stakeholder Engagement:* Broad-based stakeholder engagement is integral to the continuity and legitimacy of green initiatives. The active participation of students, faculty, administrative personnel, and external partners fosters collective ownership and reinforces the institutional commitment to sustainability (Mawonde & Togo, 2021).

Understanding these aspects provides a foundation for designing a comprehensive management model that considers the contextual realities of South African higher education.

2.3. A Multidimensional Framework of Benefits to Implement Green Initiatives in Higher Education Institutions



The implementation of green initiatives within higher education institutions is increasingly recognised as a strategic imperative, driven by a multifaceted framework of benefits that includes economic, financial, productivity, risk management, public relations, marketing, and project funding considerations (Shad et al., 2019). Although empirical findings are not universally conclusive, extant literature generally supports the assertion that green initiatives yield both tangible financial benefits (such as reduced operational expenditures) and intangible advantages, including enhanced workplace environments. These benefits may accrue either immediately or contribute to long-term institutional performance. However, retrofitting efforts often entail substantial capital investment and implementation-related costs.

- *Economic and Financial Benefits:* Economic and financial gains are among the most frequently cited advantages of adopting green practices, particularly through reductions in operating costs. These savings typically materialise over the medium- to long-term (Shad et al., 2019). In addition, government-led incentive programs (such as tax relief for the purchase of environmentally friendly products) stimulate investment in clean energy generation, thereby augmenting the national electricity supply (Department of National Treasury, 2023).
- *Intangible Benefits in Service-Oriented Contexts:* Intangible benefits are especially salient in service-driven environments. Green initiatives contribute to productivity improvements by fostering healthier indoor conditions. These gains may offset or even exceed the total energy costs associated with building operations. Enhanced indoor air quality can mitigate the prevalence of sick building syndrome and reduce employee absenteeism. Measures such as increased ventilation, natural lighting, access to outdoor views, and the use of low-toxicity materials have been shown to improve occupant well-being (Mujan et al., 2019). Furthermore, green buildings serve as strategic instruments for brand enhancement. For example, South African retailers Woolworths and Pick 'n Pay actively align their brand identities with sustainability (Mukonza & Swarts, 2020), while Nelson Mandela University (NMU) pioneered the country's first green business school (NMU, 2023).
- *Retrofitting Challenges and Long-Term Returns:* Retrofitting existing infrastructure presents notable challenges, particularly in terms of upfront capital expenditure. Universities often perceive these costs as immediate constraints; however, the long-term benefits, such as energy and water savings, as well as productivity improvements, justify the investment. Design complexity may necessitate temporary building closures, thereby extending project timelines and complicating implementation logistics (Li et al., 2022).
- *Innovation and Technological Advancement:* Institutions engaging in green innovation adopt a systems-oriented perspective that encompasses internal operations, environmental stewardship, stakeholder engagement, and community involvement (Afeltra et al., 2023). A notable example is the Pandit Deendayal Energy University (PDEU) in India, which implemented a patented solar power tree and vertical solar design. This initiative generates approximately 150,000 units of clean energy annually, mitigates 123,000 units of CO₂ emissions, conserves 8,500 square feet of land, and yields environmental benefits equivalent to planting 185 teak trees each year (PDEU, 2023).



- *Community Engagement and Sustainability Education:* Community involvement enhances public awareness of environmental issues and empowers individuals to influence decisions affecting their local environments (Goodman et al., 2020). The University of California at Santa Barbara exemplifies this approach through its commitment to sustainability reporting and local food sourcing, with 40% of its food procured from farms within a 150-mile radius. The university collaborates with non-profit organisations and research institutions to cultivate future sustainability leaders (University of California, 2023).
- *Student Empowerment Through Participatory Governance:* Empowering students to participate in sustainability governance fosters environmental literacy and encourages interdisciplinary engagement. Institutions such as the University of South Florida have introduced mechanisms, such as the Student Green Energy Fund, that enable students to propose and vote on sustainability projects (University of South Florida, 2023). This participatory model supports academic and professional development aligned with environmental stewardship (Sierra & Suárez-Collado, 2021).
- *Validated Benefits of Green Initiatives in Universities:* Tshivhase and Bisschoff (2023a; 2023b) identified three core benefits of implementing green initiatives in universities: cost-saving strategies, convenience and business continuity, and reduced energy costs. These strategies are detailed as:
 - Cost-saving strategies: The reduction in operational expenses remains the most frequently cited benefit of green practices (Bhatta et al., 2020), with long-term financial gains (Averfalk & Werner, 2020).
 - Convenience and business continuity: These benefits are particularly relevant to service-oriented institutions, where green initiatives enhance productivity through improved operational efficiency and continuity (Evandro, 2021; Kim et al., 2022).
 - Reduced energy costs: Energy efficiency is a pivotal strategy for mitigating climate change, lowering operational costs, and enhancing institutional competitiveness. It also significantly contributes to achieving net-zero carbon emissions through decarbonisation efforts (Misztal et al., 2021).

2.4. Barriers to the Implementation of Green Initiatives in Higher Education Institutions

An extensive review of the current literature on the implementation of green initiatives within university campuses reveals two dominant categories of barriers: financial and organisational (Li et al., 2020). Scholarly perspectives diverge on whether sustainable practices entail higher initial capital costs than conventional approaches. While some studies suggest that green initiatives require greater upfront investment, others argue that such costs are either comparable or offset by long-term operational savings (Álvarez Jaramillo et al., 2019; Wills, 2020). Under favourable conditions, sustainable infrastructure may entail equivalent capital expenditure while yielding reduced operating costs over time.

- *Organisational Barriers:* Organisational dynamics play a critical role in the successful implementation of green initiatives. Key factors include leadership commitment, the



establishment of measurable sustainability targets, and interdisciplinary collaboration (Roscoe et al., 2019). Strong leadership, particularly the presence of a project champion and support from senior administration, is essential for driving institutional change (Ali et al., 2021). Formulating quantifiable sustainability indicators, ranging from procurement policies to material-use metrics, is a prerequisite for effective implementation (Mishra, 2022). Moreover, collaboration between academic researchers and facilities management personnel enhances operational efficiency, fosters sustainable design expertise, and facilitates the practical application of research, thereby strengthening institutional capacity and grant acquisition potential (Anwar et al., 2020).

- *Financial Constraints:* Access to capital remains a significant impediment to sustainability investments. Universities may face limitations in internal funding, reluctance to incur debt, or restrictive capital budgeting procedures that deprioritise green projects (Purwandani & Michaud, 2021). These financial constraints often result in the postponement or abandonment of sustainability initiatives.
- *Cognitive and Behavioural Limitations:* Bounded rationality, as characterised by limited time, attention, and cognitive capacity, impedes optimal decision-making and fosters reliance on routine behaviours, thereby discouraging innovation (Ghadge et al., 2021). This cognitive limitation may lead individuals to overlook viable opportunities for sustainability.
- *Hidden Costs:* Hidden costs pose a substantial threat to the financial viability of green initiatives. These include the costs associated with identifying opportunities, operational disruptions, increased maintenance, reduced service quality, and staff retraining (Charef et al., 2021). Due to their intangible nature, such costs are often difficult to quantify, leading institutions to forgo otherwise profitable sustainability measures.
- *Information Asymmetry:* Imperfect information frequently exacerbates project risk. A lack of awareness regarding green technologies, limited staff knowledge, and difficulties in accessing reliable data contribute to underinvestment in sustainability initiatives (Abdel-Baset et al., 2019).
- *Risk and Uncertainty:* Perceived risks range from regulatory and technical uncertainties to macroeconomic volatility. These risks may rationally dissuade institutions from pursuing green ventures (Bhandari et al., 2019). In the South African context, although student demand remains relatively stable, financial pressures associated with the National Student Financial Aid Scheme introduce additional uncertainty.
- *Structural Disincentives:* Split incentives present a structural challenge to sustainability implementation. When departments are not directly accountable for utility costs, these costs are often absorbed as organisational overheads. There is little motivation to invest in energy efficiency, resulting in missed opportunities for sustainable improvements (Agyekum et al., 2022).
- *Empirical Identification of Key Barriers:* Exploratory factor analysis identified three principal barriers to the implementation of green initiatives in universities: lack of awareness and training, managerial attitudes, and resistance to change (Bisschoff & Tshivhase, 2023a). The



exclusion of environmental education from South Africa's primary and secondary curricula contributes to limited awareness (Bonnett, 2021). Managerial beliefs and expectations significantly shape institutional sustainability agendas (Ogiemwonyi et al., 2020), while reluctance to adapt may manifest overtly or covertly through language and behaviour (Cox & Cox, 2020).

2.5. Strategic Leadership and Institutional Readiness for Green Initiative Implementation

The role of top management and strategic leadership in sustainability strategy is central to the formulation and execution of sustainability initiatives within organisations. Effective implementation requires a commitment to sustainable leadership, grounded in ethical values and supported by a robust organisational culture that permeates all business activities (Graves et al., 2019). Organisational sustainability has emerged as a core competency, necessitating sustained managerial effort to maintain competitive advantage. To institutionalise sustainability, organisations may establish dedicated roles, such as the Corporate Sustainability Officer, to oversee environmental performance across operational domains (Henry et al., 2019).

Top management plays a pivotal role in cultivating organisational capabilities for green innovation, including sustainable product design and manufacturing. Empirical evidence suggests that such initiatives can significantly enhance both strategic and environmental performance (Burki et al., 2019). Moreover, leadership commitment is essential for identifying and prioritising the factors that contribute to improved sustainability outcomes. Studies have demonstrated that top management engagement positively influences green performance through targeted initiatives and adaptive strategies that respond to environmental uncertainties (Haessler, 2020; Woo & Kang, 2020).

Adapting these diversified industry-based factors to the university context offers valuable insights for higher education institutions. Given contextual differences in implementation, these factors warrant further scrutiny to determine their applicability to universities, particularly within the South African context. Confirmatory literature support was employed to validate the retention of five key factors deemed critical for assessing progress in implementing green initiatives at public universities. These factors are: (1) cost of green products; (2) awareness, training, and education; (3) top management attitude and commitment; (4) digital transformation; and (5) the establishment of a sustainability and accountability committee.

Strategically integrating and monitoring performance can ensure the effective implementation of green initiatives, necessitating a structured strategic process. Universities must integrate sustainability into institutional policies, guidelines, and performance frameworks to ensure long-term viability (Ogbu et al., 2023). Monitoring and evaluation mechanisms should be established using measurable indicators to assess progress and facilitate transparent reporting (Wojewska et al., 2021). Continuous improvement strategies are essential for refining sustainability practices and enhancing their effectiveness over time (Kulkov et al., 2024).

Likewise, advanced technologies, such as digitalisation and artificial intelligence, can be leveraged to optimise operational efficiency and support sustainable infrastructure development (Zeemering, 2021). However, successful implementation requires inclusive engagement with all stakeholders. All relevant actors must be involved in the allocation and reallocation of resources,



securing funding, deploying appropriate technologies, and mobilising human capital to support green university projects (Yuan et al., 2024). In this regard, training and education are foundational to building institutional capacity and fostering a culture of sustainability (Styk & Bogacz, 2022). Table 1 summarises the factors and their supporting literature.

Table 1: Green initiatives implementation models and factors examined

No.	Factor	Industry	Literature source
1	Marketing strategy	Construction	Wirtz and Zeithaml (2018), Chang <i>et al.</i> (2019), Bukhari <i>et al.</i> (2020)
2	Pressure from customers	Hospitality	Deraman <i>et al.</i> (2017), Shashi <i>et al.</i> (2020), Han (2021)
3	Awareness, training, and education	Supply chain	Burki <i>et al.</i> (2019), Jadhav <i>et al.</i> (2019), Bhutta <i>et al.</i> (2021)
4	Mutual participation and acceptance	Information technology	Goetsch and Davis (2016), Kotler and Keller (2016), Ighalo and Adeniyi (2020)
5	Digital transformation	Food	Martzopoulou and Komninos (2019), Acar <i>et al.</i> (2019), Berggren <i>et al.</i> (2019)
6	Cost of green products	Logistics	Ghadimi <i>et al.</i> (2021), Shurrab <i>et al.</i> (2019), Lambrechts <i>et al.</i> (2019)
7	Environmental regulations and laws	Supply chain	Taghikhah <i>et al.</i> (2019), Ghebrehiwet (2019), Dai <i>et al.</i> (2021)
8	Top management attitude and commitment	Manufacturing	Piyathanavong <i>et al.</i> (2019), Mao and Wang (2019), Mabrouk and Ibrahim (2021)
9	Improved communication strategies	Supply chain	Kazancoglu <i>et al.</i> (2021), Dahlmann and Roehrich (2019), Makhitha and Ngobeni (2021)
10	Committee for sustainability accountability	Human resources	Bribena (2019), Macke and Genari (2019), Chams and García-Blandón (2019)

Source: Tshivashe (2024)

Research Design and Methodology

Research Paradigm and Design

A positivist paradigm and were selected for the study.

Research Approach

This study follows a quantitative design.

Research Method



The quantitative data from the questionnaires validated the refined list of qualitative/theoretical antecedents and identified the latent variables (or factors) (Asvat *et al.*, 2018; Shaikh *et al.*, 2017; Nag *et al.*, 2025). This methodology was also successfully applied in other studies (Imandin, 2015; Bester & Bisschoff, 2018) to assess various managerial dependent variables, including brand loyalty, managerial skills, stress management, and employee retention. Imandin *et al.* (2016) further validated the factors and antecedents, establishing a model to assess employee engagement. This study employs a similar methodology to validate the antecedents and measurement criteria and to identify the factors that contribute to developing a theoretical model for measuring and managing the implementation of green initiatives at SAU.

Population and Sample

The population comprises executive directors, assistant directors, senior managers, senior lecturers, and faculty deans at universities in SA. There are over 23 universities in South Africa. However, only eight were selected because universities showed strong interest in implementing green practices on their websites. Because the population was limited, the population rather than a sample was the target. The senior personnel were expected to complete the questionnaires.

Research Instrument

The questionnaire comprised two sections: Section A: Demographics and Section B: Antecedents and measuring criteria. Section A comprises three questions used to compile respondents' demographic profiles. Section B has five subsections that address the antecedents. The criteria were presented in a statement format, and respondents specified their level of agreement or disagreement using a five-point Likert scale. Section B contained 18 criteria and 74 sub-criteria.

Data Collection

Information was provided to the universities by the Human Resources departments as soon as the Research Ethics Committees consented to the study. Assistance was received from the Human Resources departments of the eight universities with the distribution of the questionnaire via email. In total, 150 questionnaires were distributed; 144 were completed and returned, yielding a response rate of 96%. Completed questionnaires were examined, analysed, and coded. The data were captured in an Excel spreadsheet and analysed using IBM's SPSS and AMOS statistical software (version 29).

The data were tested for suitability and showed limited skewness (0.202) and kurtosis (0.401). The sample was adequate as per Kaiser's criterion ($KMO \geq 0.837$), and Cronbach's correlation coefficient showed acceptable reliability and internal consistency ($\alpha = 0.749$). Bartlett's Test of Sphericity was significant at the 99% confidence interval, $\chi^2(66) = 555.10$, $p < 0.01$, indicating that the correlation matrix is not an identity matrix and that multivariate statistics, such as exploratory or confirmatory factor analyses, are appropriate (Field, 2017; Pallant, 2020).

Ethical Considerations

The Scientific Committee of the NWU Business School approved the study, after which the Committee of Ethics in the Faculty of Economic and Management Sciences at North-West University issued a formal ethics certificate (No. NWU-00588-22-A4) for this "Low-risk study". The



eight universities also issued research consent letters after the researcher complied with their research participation processes.

Results and Findings

The results comprise the demographic profile and the model's validation for implementing green initiatives at South African universities.

Profile of Respondents

Most respondents (90%) have been working at their universities for more than 5 years, indicating that many (72%) have over 10 years of managerial experience at a university. Analysing the level of experience, 44% of respondents are at a senior management level or higher, while 24% are at a dean's level. This means that 68% of the respondents have experience in senior management. But do these variations in the profile suggest significant differences in their views? Using both the Analysis of Variance (ANOVA) and Cohen's effect size (d) indicated that few significant differences on individual questions exist, and where they do, these differences are small (Cohen's $d \leq .30$). This meant that the total dataset can be used to validate the model with confirmatory factor analysis (CFA).

4.2. Model Validation

Figure 1 illustrates the validated model for implementing green initiatives at a South African university.

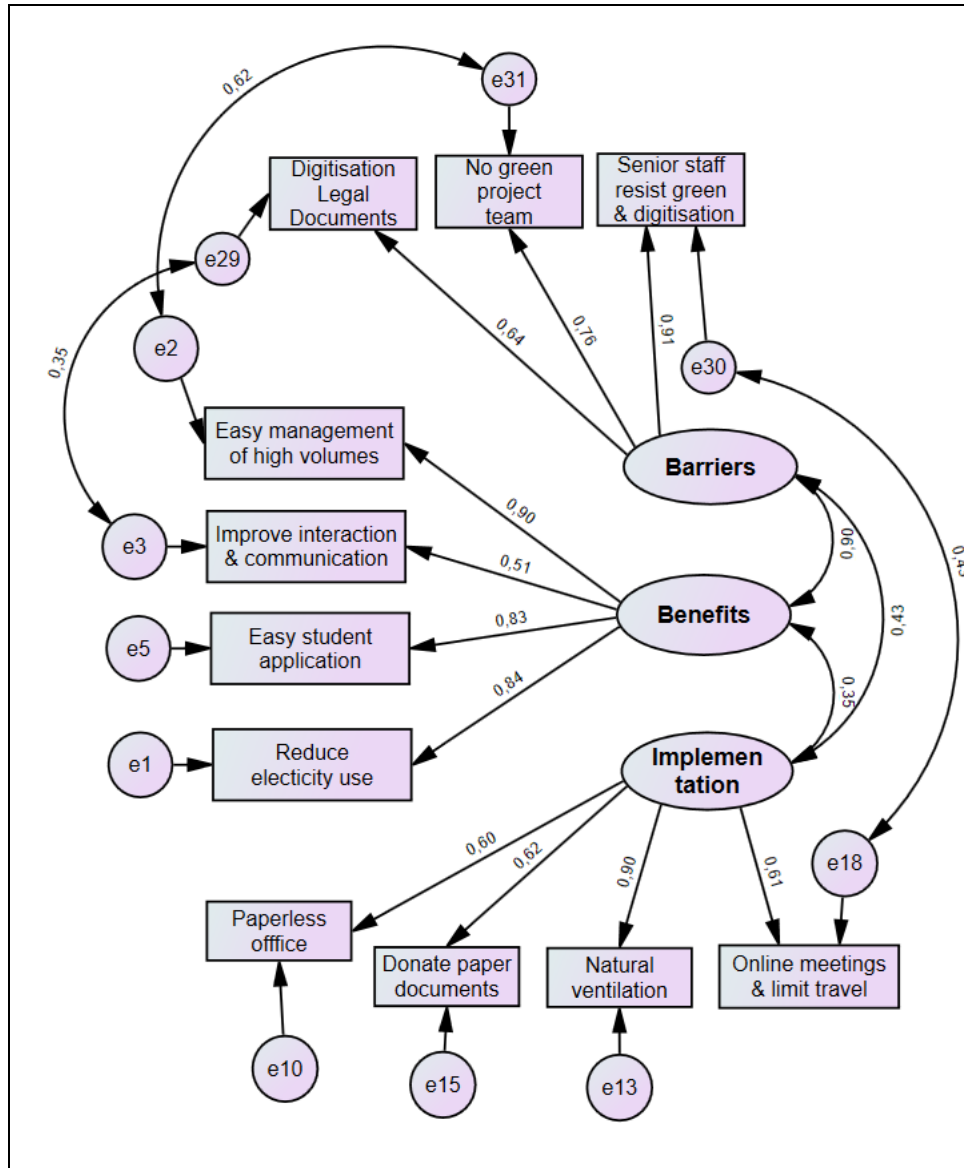


Figure 1: The validated model

The confirmatory factor analysis indicates an acceptable model fit based on several widely recognised fit indices. The Comparative Fit Index (CFI) was 0.940, exceeding the commonly accepted threshold of 0.90, suggesting a good fit between the hypothesised model and the observed data. Similarly, the Tucker-Lewis Index (TLI) was 0.913, which meets the criterion for acceptable model fit, indicating that the model accounts well for the data's complexity. The Normed Fit Index (NFI) yielded a value of 0.905, further supporting the model's adequacy (Hair et al., 2022; Jones, 2024; Arbuckle, 2024). However, the Root Mean Square Error of Approximation (RMSEA) was 0.10, which is slightly above the conventional cutoff of 0.08 for acceptable fit. However, RMSEA indices between 0.08 and 0.10 suggest a mediocre fit (Jones, 2024). While the RMSEA value warrants cautious interpretation, the overall pattern of fit indices supports the conclusion that the model demonstrates a reasonably good fit to the data. In exploratory studies (such as this study), particularly when the model is being tested for the first



time or when sample sizes are limited, researchers may tolerate RMSEA values up to 0.10, provided that other fit indices (such as the CFI, TLI, or NFI) support the model's adequacy (Hu & Bentler, 1999), especially in cases where the sample size is less than 200 (Kenny et al., 2015; MacCallum, et al., 1996). The model fit indices, although suggesting an acceptable fit, should be reconfirmed in the future with a larger sample and an improved model (Kenny et al., 2003).

The model has satisfactory composite reliability for barriers, benefits, and implementation, as indicated by Joreskog's rho (0.861, 0.818, and 0.782) (Raykov et al., 2024). Regarding discriminant validity, barriers, benefits and implementation ($r = 0.90, 0.43$ and 0.35) demonstrated satisfactory discriminant validity ($AVE^2 = 0.232, 0.367$, and 0.379) (Rönkkö & Cho, 2022). The model's convergent validity is satisfactory for barriers and benefits ($AVE = 0.605$ and 0.616), whereas implementation's convergent validity is marginally below the required value of five ($AVE=0.482$) (Fornell & Larcker, 1981; Hu & Bentler, 1999).

Four criteria have a regression weight below the desired 0.70 (*Improve interaction & communication, Paperless office, Donate paper documents* and *Online meetings & limited travel*). These criteria were retained because they are conceptually important to the latent constructs and removing one deteriorates the model fit indices. This is an acceptable practice. Hulland (1999) argued that 0.40 could be an acceptable regression weight loading. Likewise, Henseler et al. (2009) suggested that criteria with regression weights between 0.40 and 0.70 should be reviewed for conceptual importance to the latent variable before elimination.

A strong, significant correlation exists between the latent variables *Barriers* and *Benefits* ($r = 0.90$; $p \leq 0.05$), while medium significant correlations exist between *Benefits* and *Implementation* ($r = 0.35$; $p \leq 0.05$) and *Barriers* and *Implementation* ($r = 0.43$; $p \leq 0.05$). Some intercorrelations also exist between the measuring criteria. *Senior staff resist green initiatives* correlated with *Online meetings & limited travel* ($r=0.43$; $p\leq0.05$), *Digitising legal documents* correlates with *Improved interaction & communication* ($r=0.35$; $p\leq0.05$), and *Easy management of high volumes* correlates strongly with the *Number of green project teams* ($r=0.62$; $p\leq0.05$).

Discussion

This model provides a structured approach to coordinate sustainability efforts, ensuring accountability and long-term viability. Based on empirical evidence, the relationships among barriers, benefits and implementation of green movement initiatives within South African universities are investigated and the statistically significant bivariate correlations between the constructs were also confirmed. The highest correlation between barriers and benefits ($r = 0.90$; $p \leq 0.05$) indicates that as the institution becomes increasingly aware of the problems, it starts to realise the strategic value of sustainability actions. This corroborates with Tshivhase and Bisschoff (2023a), who found that universities face resource limitations, while also recognising that sustainability programmes are strategically and operationally advantageous. The result is also supported by the literature on the dichotomy of institutions' progress in green initiative adoption, reflecting diverse, respective thinking on sustainability while coping with and interacting with systemic and operational barriers (Sippel & Visser, 2020; Mawonde & Togo, 2021).

Implementation correlates moderately with *Barriers* ($r = 0.43$; $p \leq 0.05$) and *Benefits* ($r = 0.35$; $p \leq 0.05$) on the 95% confidence interval. This suggests that Institutions were more likely to



implement green projects or measures when they knew the potential benefits of the projects or activities, as well as the reasons for constraints, and when leadership commitment was in place to act. This aligns with findings in the literature indicating that achieving sustainability requires strong leadership commitment, strategic alignment, and resource mobilisation (Ali et al., 2021; Graves et al., 2019). Furthermore, the findings from this study reinforce that financial and structural constraints are key barriers. The uniqueness of these findings lies in their alignment with evidence from both South African and international sources, which point to prevailing spending restraint, inadequate management commitment, and a lack of capacity as barriers to the adoption of sustainability (Purwandani & Michaud, 2021; Van Schalkwyk et al., 2022).

On the other hand, the weak convergent validity of implementation indicators on the margin revealed differences in institutional maturity, as evidenced by a discrepancy between strategic intent and a fragmented sustainability landscape of siloed ventures with limited cross-campus relationships. This corroborates research by Adams and Luiz (2022) and Rhodes University (2025), which indicates that not all HEIs demonstrate equal commitment to sustainability: some institutions are leaders in the adoption process, whereas others are behind due to resource and competency shortfalls.

However, the direct effect of benefits on implementation confirms that, despite these risks, sustainability still yields strong returns across its total relationships. Universities that understand the concepts of cost savings, operational efficiency, and reputation benefits appear more inclined to adopt sustainability efforts, consistent with previous studies indicating returns over time (Bhatta et al., 2020; Averfalk & Werner, 2020). Benchmarked universities around the world, such as the University of California (UC) system, have also adopted this stance, demonstrating that strong governance structures and student involvement can accelerate sustainability outcomes.

In summary, the study model has emerged from validation, demonstrating that a practical tool for university leaders to integrate sustainability into institutional strategy and to promote accountability, alignment, and performance over time has been brought to life. Findings indicate that developing leadership, enhancing sustainable competencies, mainstreaming monitoring and evaluation mechanisms, and mobilising financial support are essential drivers for advancing the sustainability turnaround of South African universities.

Acceptance or rejection of hypotheses

The hypotheses are accepted and rejected based on the results and the above discussion:

H₀: There are no significant relationships between *Barriers*, *Benefits* and *Implementation* at South African Universities. *Rejected*. Significant relationships do exist between the antecedents.

H₁: There is a significant relationship between *Barriers* and *Benefits* at South African Universities. *Accepted*. A strong, significant relationship exists ($r = 0.90$; $p \leq 0.05$).

H₂: There is a significant relationship between *Barriers* and *Implementation* at South African Universities. *Accepted*. A medium, significant relationship exists ($r = 0.43$; $p \leq 0.05$).

H₃: There is a significant relationship between the *Benefits* and *Implementation* at South African Universities. *Accepted*. A medium, significant relationship exists ($r = 0.35$; $p \leq 0.05$).



Conclusions and Future Research

This study contributes to the growing body of knowledge on sustainability management within South African higher education. This study contributes to the discourse on sustainability in higher education by confirming that both perceived barriers and recognised benefits significantly influence the implementation of green initiatives in South African universities. The findings reveal that universities increasingly recognise the strategic value of sustainability, even as financial, structural, and organisational challenges persist. Institutions that demonstrate greater awareness of barriers also show a stronger appreciation of the benefits of sustainability, highlighting the interplay between internal constraints and institutional learning. Furthermore, it identified the key factors influencing the success of green initiatives and proposed a practical model for managing and evaluating such programmes. The results affirm that leadership commitment, stakeholder engagement and strategic integration are essential for success.

The confirmed relationships across constructs underline the importance of leadership commitment, strategic planning, and resource mobilisation in achieving sustainable campus practices. While implementation remains uneven, the validated model provides a practical roadmap for institutional leaders to strengthen sustainability governance, integrate sustainability into core strategies, and cultivate a culture of green innovation. Despite existing barriers, the benefits of adopting green initiatives, which range from cost efficiency to enhanced institutional reputation, justify sustained investment. Future research should extend the application of this model to incorporate student perspectives and examine digital monitoring tools for sustainability reporting. By embedding the proposed management model into their strategic frameworks, South African universities can strengthen their leadership in environmental stewardship and sustainable development.

Indeed, strengthening financial allocations, capacity building, and monitoring mechanisms will be essential to advancing the green university agenda. Overall, this research highlights the importance of coordinated, well-resourced, and strategically aligned sustainability frameworks in accelerating South African universities' transition toward environmentally responsible and future-ready institutions.

Future researchers could focus on the management strategies to sustain the green drive at universities and to identify emerging criteria, which would be beneficial to further green initiatives.



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South Africa's Green Entrepreneurship and Climate Initiatives: A Case of a Financially Challenged Renewable Energy-Efficient Technology Project in Cape Town.

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Abstract

South Africa's engagement with the United Nations Framework Convention on Climate Change (UNFCCC), on the green economy and the Clean Development Mechanism (CDM) involves a national commitment to transition toward a low-carbon, climate-resilient society despite a heavy reliance on fossil fuels. The country views the green economy as a means to achieve sustainable development, poverty reduction, and job creation, while the CDM was an important early mechanism for accessing climate finance and technology transfer. The study argues that one such initiative to promote a green economy is green entrepreneurship, in South Africa, the Kuyasa CDM project in Khayelitsha, Cape Town. The project witnessed the retrofitting of 2,309 government-subsidized houses with Renewable Energy-Efficiency Technologies (REETs), namely, Solar Water Heaters (SWHs), Compact Fluorescent Lights (CFLs), Insulated Ceilings (ICs), and Hot Pots. 87 local community residents participated in the installation of the REETs. Based on this literature, a conceptual model is constructed with the following variables: skills transfer, experience, tools, venture formation legalities, sustainable quadruple (University-Industry-Government-Community) engagement, and, resultantly, green entrepreneurship. The systems theory, energy transition, and community empowerment theory are employed to guide the study. Findings from a quantitative study with 370 participants proved that the project had a great impact on skill development, and with at least a 2-year of experience in the retrofitting of the REETs, the project developers left the tools for the community. In addition, skills gained were in the areas of carpentry (ICs), metal work (SWH), electricity wiring (CFL), general installation (Hot Pots), and general administration. Project developers and designers anticipated that the residents would also take up the initiative to conduct maintenance activities of their REETs. This did not materialize. There was low up take of entrepreneurship initiatives. Hence, the objective of this study is to encourage green entrepreneurship initiatives by project beneficiaries as a means to close the gap of financing project maintenance costs. Evidence showed some of the REETs, 15 years after installation, were malfunctioning, falling off due to a lack of maintenance. It is recommended that residents need to be encouraged to partake in green entrepreneurship ventures to maintain their REETs. Also, as a form of discouraging greenhouse gas emissions. In addition to our proposed conceptual framework, residents need to be re-educated, retrained around maintaining REETs and the benefits of green entrepreneurship and economy. Convenient



venture registration processes need to be implemented with the full participation of the university, industry, government, and community (Quadruple Helix).

Keywords: clean development mechanism (cdm), green entrepreneurship, maintenance, renewable energy-efficiency technologies (reets), skills transfer/skill development.

Introduction and contextual background

South Africa is a significant global carbon polluter, it emits significantly more than other top African polluters like Egypt, Algeria, and Nigeria primarily due to its heavy reliance on coal-fired electricity generation (Zerizghi et al, 2022). In response to global calls for the reduction of greenhouse gas (GHG) emissions, the South African government ratified the Kyoto Protocol in 2002 and the Paris Agreement in 2016 (Maphosa, 2024, p.18). A primary vehicle for these climate initiatives is the Clean Development Mechanism (CDM), which allows developing countries to implement emission-reduction projects and sell tradeable Certified Emission Reductions (CERs) Lo & Cong, (2022, p.2). The Kuyasa CDM project in Khayelitsha, Cape Town, stands as a landmark initiative, being the first CDM project in Africa and the first globally to be awarded Gold Standard status (Maphosa et al, 2020, p.29). Completed in 2010, the project retrofitted 2,309 low-cost housing units with solar water heaters (SWHs), insulated ceilings (IC), and compact fluorescent light bulbs (CFLs) (Goldman, 2010). 87 residents were trained in technical fields such as plumbing, carpentry, and electrical work to install solar water heaters (SWHs) and insulated ceilings. This skills transfer included not only technical mastery but also non-technical knowledge, such as energy-saving practices and project management (Goldman, 2010; Maphosa, 2024).

This paper evaluates the financial sustainability of the Kuyasa project, examining the intersection of climate mitigation and green entrepreneurship in a low-income urban context. To help guide the study “The Integrated Participatory Sustainable Theoretical Framework is proposed” which integrates the systems theory, sustainability theory, community participation and empowerment, and energy transition theory. Conceptually; skills transfer, experience, tools, venture formation legalities, sustainable quadruple (University-Industry-Government-Community) engagement, and, resultantly green entrepreneurship. The next session discusses the literature review.

Literature Review

Financial sustainability in the context of renewable energy-efficient technology (REET) projects is defined as the assessment that a project will have sufficient funds to meet all financial obligations throughout its planned life cycle (Govindaraju, & Mabel, 2015 in Maphosa, 2024, p.28). The CDM was intended as an innovative financial tool to facilitate technology transfer from industrialised to developing nations (Pandey, de Coninck, & Sagar, 2022, p.2). However, the CDM has been significantly underutilized in sub-Saharan Africa, which hosted only 1.4% of global CDM projects between 2008 and 2009 (Maphosa, 2024, p.37). Barriers include a lack of institutional capacity, high transaction costs, and small project scales that fail to cover the bureaucratic expenses of United Nations verification (Ntuli, 2012, p.3). To forego some of these financial challenges regarding maintenance costs due to heavy reliance on CDM mechanisms, the study encourages green entrepreneurship initiatives. Similarly, despite the advantages of green entrepreneurship.



Green entrepreneurship in Sub-Sahara Africa struggles due to high costs of green tech, lack of funding and supportive policies, weak infrastructure, skills gaps, market awareness issues, and bureaucratic hurdles, all compounded by poverty, political instability, and prioritizing immediate economic needs over long-term environmental goals, hindering growth despite opportunities (Dzingirai et al, 2024).

Green entrepreneurship is defined as activities that are consciously addressing environmental/social problems/needs through implementation of entrepreneurial ideas amidst high risks and expectation of net positive impact on environment and financial sustainability (Green Profit, 2012 in Muo & Azeez, 2019, p.19). The authors go further to describe a green entrepreneur as one who starts and runs an entrepreneurial venture that is designed to be green in process and products (Muo & Azeez, 2019, p.19). For example, according to ESMAP (2012, p. 8), impact surveys conducted by SouthSouthNorth (SSN), the Kuyasa project implementer, during 2008-09 indicate that the project has had a marked impact on the socio-economic well-being of the target community. These benefits have included Local Job Creation. This project contributed to local and regional employment for the community. The residents were trained to become plumbers, electricians, and builders, and they learned to install and maintain renewable and energy-efficient technologies. The project created 87 job opportunities locally at Kuyasa and offered green entrepreneurial opportunities for the trained residents at a provincial and national level (Goldman, 2010; Maphosa, 2024). To argue the impact of encouraging green entrepreneurship as a means to forego high maintenance costs and ensure financial sustainability of the Kuyasa renewable energy efficient project a theoretical framework is proposed.

The Integrated Participatory Sustainable Framework (IPSF) is proposed. Theoretical frameworks for such projects often integrate Systems Thinking (Basile, & Caputo 2017), Sustainability Theory (Robertson, 2021), and Community Empowerment (Zimmerman, 2000). Systems theory posits that projects operate in open environments where agents like the community, government, and utility providers must be interlinked for longevity. Energy Access and Transition Theory suggests that as incomes rise, households ascend an "energy ladder" from dirty fuels like paraffin to modern, clean energy (Drewello, 2022; Maphosa, 2024). Despite these theoretical ideals, many African CDM projects struggle with financial self-sustainability once initial grants are exhausted (Maphosa and Bayat, 2024). Green entrepreneurship initiatives from project participants are often a challenge were there are support challenges from university, industry, government, and community (Quadruple Helix) (Maphosa, 2024). Therefore, funding these projects is anticipated to remain a challenge, and potential funding gaps for maintenance activities need to be addressed such as green entrepreneurial initiatives.

Research Design and Methodology

This study utilized a concurrent triangulation mixed-methodology design to obtain a comprehensive understanding of the research problem. The research was grounded in a critical realism paradigm, acknowledging that reality exists independently of perception while remaining susceptible to individual standpoints (Lawani, 2021). Quantitative segment, a semi-structured questionnaire was administered to a random sample of 370 residents of Kuyasa, Khayelitsha. The data was analysed using SPSS software to generate descriptive statistics and correlation analyses. Qualitative segment, in-depth interviews were conducted with 20 energy industry



experts, including project designers from SouthSouthNorth, municipal officials, and university researchers. The qualitative data were analysed using ATLAS.ti software to identify recurring themes. Financial Analysis, the study calculated the Net Present Value (NPV) of the Kuyasa project to determine its long-term economic viability.

Results and Findings

4.1 Performance of Renewable Energy-Efficient Technologies (REETs)

At the project completion, all 370 respondents had a solar water heater, compact fluorescent lights and an insulated ceiling installed. Besides the three REET interventions mentioned, 800 households were supplied with a solar cooker or a wonder hot box (Walsh et al. 2011). Thus, the project had four REET interventions in total. Table 1 reports on three of the four installed technologies in the Kuyasa community. The implications of these findings on encouraging green entrepreneurship as a means to address maintenance costs is further brought out in this section.

Table 1: Cross-tabulation of the group that ‘Can respond’ = Yes to having either a solar water heat/geyser, CFL lamps, insulated ceiling, or clean cooking appliance (n = 370)

Energy-efficient intervention	Provided/installed (Yes/No)	‘Can respond’ = Yes (Count)	Per cent (%)
Have a solar water geyser? (Heating water)	No	91	24.6
	Yes	279	75.4
Do you have an insulated ceiling? (Warmth and cooling temperature)	No	32	8.6
	Yes	338	91.4
Energy saver globe (CFL) installed? (Lighting)	No	5	1.4
	Yes	365	98.6

Approximately 75.4% of residents confirmed they still have and benefit from a functioning SWH, while 91.4% still have insulated ceilings. However, 24.6% of SWHs were no longer operational due to rust, leaks, or damage from a severe storm in 2017. Residents expressed high satisfaction with the CFLs (88.9%), though some have reverted to incandescent bulbs because they are R5 to R10 cheaper to replace. These results concur with the findings in Maphosa (2024, p.105).

4.2 Maintenance and Community Contribution

A critical finding was that 96% of residents reported their SWHs had received no professional maintenance since installation Table 2.

Table 2 Whether or not they had been maintenance on solar water geysers? (n =370)



(Maintenance on solar water geyser) X (Income) cross-tabulation

		Count (%)				
Income		< R2 000	R2 000- R4 000	R4 001- R6 000	R6 001 +	Total
Maintenance of solar water geyser	No	156 (42%)	107 (29%)	51 (14%)	41 (11%)	355 (96%)
	Yes	5 (1.4%)	4 (1.1%)	4 (1.1%)	2 (0.5)	15 (4%)
Total		161	111	55	43	370 (100%)

While 90% of residents did not know who was responsible for maintenance (Maphosa, 2024). 82,9% confirmed to “NO Fixing” when the geyser broke down (Maphosa, 2024). Whilst, 61.7% indicated a willingness to contribute monthly fees for repair services. The preferred contribution range for most was R41-R50 per month (Table 3).

Table 3: How much are you willing to pay towards maintaining the SWH per month (n = 230)

If yes, how much are you willing to pay toward maintaining the solar water geyser?
X ‘Can respond’= Yes cross-tabulation

		‘Can respond’ = Yes (Count)	Per cent (%)
If yes, how much are you willing to pay towards maintaining the solar water geyser?	R0-R10	17	7.4
	R11-R20	33	14.3
	R21-R30	22	9.6
	R31-R40	14	6.1
	R41-R50	79	34.3
	R91-R100	41	17.8
	R101 and above	15	6.5
	Any amount the community agrees on	9	3.9



If yes, how much are you willing to pay toward maintaining the solar water geyser?

X 'Can respond'= Yes cross-tabulation

	'Can respond' = Yes (Count)	Per cent (%)
Total	230	100

Table 3, the majority (34.3%) of residents were willing to contribute between R41-R50, followed by 17.8% who were amenable to a monthly contribution of R91-R100, 14.3% agreed to R11-R20, and 3.9% highlighted that they were willing to contribute any amount the community agrees on as highlighted in Table 3. The residents showed commitment to contributing towards maintaining their technologies. Most residents were willing to contribute at least R20/month and upwards (Maphosa, 2024).

If all 2 309 households paid R20/month, the project could receive R46 180/month (2 309 households x R20 = R46 180). Annually, the project could reap R554 160 (R46 180 x 12 months). From 2010 until 2020, the project could have acquired R5 541 600. Excluding any costs, these finances could have helped fund the repair and maintenance of the REETs. The challenge lies in finding an institutional collection mechanism to achieve the actual collection

Naidoo (2018, p. 92) noted that various projects used different maintenance plans for their SWHs. In the SWH rollout of Ivory Park, the supplier of the SWHs was requested to train local members of the client communities in front-line fault detection and minor repair work (Maphosa, 2024). Each year, for 15 years, the project's implementer would have to provide a one-month training course on the technical and financial aspects of SWH maintenance. This did not happen at Kuyasa (Maphosa, 2024).

4.3 Sustainable Livelihood Opportunities for Community Members

Kuyasa project provided participation and training sessions for the community to install the REETs affirming Wlokas (2011). Table 4 and Table 5 provide an overview.

Table 4 Participation in installing SWH, insulated ceilings and CFL globes (n = 370)

		'Can respond' =	Per cent
Participated in putting up solar water geyser X 'Can respond' cross-tabulation			
Participated in putting up solar water geyser	No	292	78.9
	Yes	78	21.1
Total		370	100
Participated in putting up insulated ceiling X 'Can respond' cross-tabulation			
Participated in putting up insulated ceiling	No	302	81.6
	Yes	68	18.4



Total		370	100
Participated in installing energy saver globes X 'Can respond' cross-tabulation			
Participated in installing energy saver globes	No	293	79.2
	Yes	77	20.8
Total		370	100

20% of the respondents participated in installing the REETs. This contributed towards job creation and sustainable entrepreneurship skills creation, which studies have confirmed (Jain & Jain, 2017). As a green project, this reduced energy production costs, job creation, foreign investment, and buy-in from local stakeholders (Jain & Jain, 2017, p. 721). Still, it did not critically address long-term employment opportunities.

Table 5 Received training in putting up SWH, ceiling, and CFL globe (n = 370)

		'Can respond' = Yes (Count)	Per cent (%)
Receive training in putting up the solar water geyser, 'Can respond' cross-tabulation			
Receive training in putting up the solar water geyser	No	354	95.7
	Yes	16	4.3
Total		370	100
Receive training in putting up the insulated ceiling, 'Can respond' cross-tabulation			
Receive training in putting up the insulated ceiling	No	361	97.6
	Yes	9	2.4
Total		370	100
Receive training in installing the energy saver globe X 'Can respond' cross-tabulation			
Receive training in installing the energy saver globe	No	364	98.4
	Yes	6	1.6
Total		370	100



Goldman (2010) and Walsh et al. (2011) highlight that the accredited training and on-the-job experience helped a few temporary project staff find permanent employment outside the project. Some residents received training on installing the REETs (Table 5). Some project employees were now entrepreneurs. These entrepreneurship ventures were in the business categories of carpentry, steelwork, education tourism, and plumbing.

Table 6 Outcome from the training received for installing SWHs, insulated ceilings and CFL globes

		'Can respond' Yes (Count)	= Per cent (%)
How is the training in installing solar water heaters benefiting you now? X 'Can respond' cross-tabulation			
How is the training in installing solar water heaters benefiting you now?	Able to maintain and repair geysers in the community	2	12.5
	Benefited initially from the workers who were putting the geysers	8	50.0
	Can do minor maintenance work on my geyser	5	31.3
	Foresee becoming an entrepreneur	1	6.3
Total		16	100
How has the training to install an insulated ceiling benefited you now? X 'Can respond' cross-tabulation			
How has the training to install the	Can do my carpentry have become an entrepreneur	5	71.4
	Helped reduce purchasing of paraffin for our paraffin	1	14.3
	Skills gained helped save money on repairs	1	14.3
Total		7	100
How has the training to install energy-saving globes benefited you now? X 'Can respond' cross-tabulation			
How has the training to install energy-saving globes benefited you now?	Can put my globe	1	16.7
	Helped to learn a skill	3	50.0
	Reduced costs and knowledge of cheap energy	1	16.6
	We need training	1	16.6
Total		6	100

When asked, *How is the training in installing SWHs benefiting you now?* 8 + 5 out of the 16 respondents answered by highlighting that they have a fair understanding of how the geyser



works and can be maintained. Two out of the sixteen respondents highlighted that they can now do maintenance work in the community. One respondent highlighted that he could foresee being an entrepreneur through repairing SWHs. In addition, according to notes in my research diary, some residents did not clearly understand how the device heats the water. When asked How the training to install an insulated ceiling has *benefited you now?* Five out of the seven respondents highlighted that there are now carpenters. And when asked: *How has the training to install energy saver globes benefited you now?* Most respondents highlighted that they can replace a malfunctioning globe without assistance. They have also gained knowledge of energy.

In addition, SouthSouthNorth had hoped that giving the former employees the tools they had used during the project would assist them in setting up their businesses (Goldman, 2010). The former Kuyasa site manager now owns a registered business named Kuyasa Energy Services and Projects. The business involves repairing and maintaining SWHs and electric wiring. The business has expanded to Education Tourism. The Kuyasa energy services and projects have engaged in education tourism with Coffee Beans Company in the Central Business District of Cape Town, South Africa. Tourists from all over the world are invited and informed about Kuyasa Township. The respondents further highlighted that other former employees secured jobs in the Cape Town Municipality and other better organisations because of the skills they acquired from the Kuyasa project.

Table 7 Taught non-technical knowledge (n = 369)

Taught non-technical knowledge X 'Can respond' = Yes cross-tabulation			
		'Can respond' = Yes (Count)	Per cent (%)
Taught knowledge	non-technical	No	311
		Yes	58
Total		369	100

Besides the technical skills of installing the REETs, most respondents (84.3%) highlighted that the project taught them non-technical knowledge (Table 7), for example, appreciating the REETs, ways to save energy, who are the project designers/developers, project funders, and research more on how to maintain their technologies. 15.7% highlighted that the project did not teach them non-technical knowledge.

4.4 Financial Viability and Expert Insights

The Kuyasa project recorded a negative Net Present Value (NPV) of approximately -R5,259,561 (Maphosa, 2024). This was confirmed by Maphosa (2024). Experts highlighted that while the project was soundly designed for social and environmental impact, it was not financially self-sustainable. The primary revenue stream, the sale of carbon credits, was crippled by a collapse in the CER market after 2012 and exorbitant verification fees (up to R500,000 per session) charged by European consultants proved to be an expensive transaction cost for the Kuyasa project (ESMAP, 2012; Maphosa, 2024). This then should propel for green entrepreneurship initiatives as a means to cut high maintenance costs due to financial sustainability challenges.



Discussions

The Kuyasa project demonstrates a "Sustainable Chameleon" dynamic it successfully adapted to the physical environment but failed to adapt to the shifting financial climate of the global carbon market (Maphosa & Bayat, 2025). The project's heavy reliance on a single revenue source (CERs) made it vulnerable to market volatility. Furthermore, the project suffered from a major design flaw by excluding Eskom, the national utility, from the early planning phases, which prevented the project from accessing demand-side management rebates (ESMAP, 2012).

While the project failed to achieve financial self-sufficiency, it succeeded in improving indoor air quality and reducing respiratory illnesses by 76% by eliminating the need for paraffin heaters (Goldman, 2010). It also spurred green entrepreneurship, specifically the formation of the Kuyasa Energy Company, which facilitates maintenance and education tourism in the township (Maphosa, 2024).

On the other hand, the project's focus on training and participation led to tangible benefits, including maintenance and repair skills, carpentry, and energy-saving knowledge. The acquisition on non-technical skills, such as project management and energy-saving strategies, was also notable. Success stories, like Kuyasa energy services and projects, demonstrate the potential for community-led entrepreneurship.

Conclusions

The study concludes that the Kuyasa project was not financially self-sustainable in the long term. The initial expectations of the designers were only partially realistic; while they successfully delivered social and environmental benefits, the financial mechanisms were insufficient to cover the technologies' 21-year lifespan. The "freebie syndrome" providing technologies at no cost to the residents initially fostered buy-in but later created a barrier to establishing the contribution mechanisms needed for maintenance.

The project successfully empowered community members with skills and knowledge in Renewable Energy Efficiency Technologies (REETs), contribution to job creation, entrepreneurship, and energy-saving practices. However, the project's impact on long-term employment opportunities was limited.

The Integrated Participatory Sustainable Framework (IPSF) combined the Theory of Sustainability, Theory of Energy Access and Transition, Systems Thinking Approach, and Theory of Community Empowerment and Participation to foster green entrepreneurship. The sustainability theory underscored the potential of REETs to enhance households' socio-economic status, environmental preservation, and access to physical and financial assets, ultimately influencing livelihood outcomes. Energy Access and Transition highlighted factors driving households towards cleaner energy and identified financial opportunities arising from this shift. The systems thinking approach facilitated community participation in developing sustainable business models for REETs projects, promoting green entrepreneurship. Community Empowerment and Participation empowered beneficiaries to take ownership, make informed financial decisions, and maintain REETs, cultivating a sense of responsibility and entrepreneurial



spirit. This integrated framework encouraged community-led green ventures, enhancing livelihoods and environmental sustainability.

Analogy for Understanding: The project is like a bicycle designed for a flat path; it works perfectly until it hits the uphill climb of a collapsed market, at which point it requires the pedal-power of community contribution, green entrepreneurship and the study frame of utility support to keep moving forward.

Recommendations

To ensure the financial sustainability of future REET projects in low-income communities, the following is recommended:

- a. *Diversify Revenue Streams:* Projects should not rely solely on carbon credits but should integrate resident contribution mechanisms, Green Bonds, and monetized basic energy grants.
- b. *Involve National Utilities:* Eskom and local municipalities should be involved from project initiation to facilitate long-term maintenance funding and grid-integration rebates.
- c. *Implement Contractual Agreements:* Residents should be engaged in binding service contracts where they pay small monthly fees (for example, R20 per month) to ensure a pool of funds is available for repairs.
- d. *Localize Manufacturing:* Sourcing technologies from South African manufacturers rather than importing them (for example, from China) would reduce costs and ensure equipment is suited to local water and weather conditions.
- e. *Quadruple Helix:* Convenient venture registration processes need to be implemented with the full participation of the university, industry, government, and community.
- f. *Long-term project evaluation:* Assess the project's sustained impact on the community.
- g. *Skills development programs:* Develop targeted training for specific industries or needs.
- h. *Funding and resource allocation:* Secure funding to support community-led initiatives.

Practical Implications

The "Sustainable Chameleon Strategy to Overcome Financial Sustainability Challenges" should be adopted as a management philosophy (Maphosa and Bayat, 2025). Just as a chameleon rotates its eyes to monitor its surroundings and changes its skin to blend in, project managers must maintain constant environmental monitoring and remain flexible enough to transform financial mechanisms as global markets and local economies shift. This flexibility ensures that the project remains a "part of the system" rather than an isolated intervention.

The paper proposes an expansion of training more community members, focusing on in-demand skills. Similarly, provide resources and mentorship for start-ups and small businesses. Partner with local organisations to create job opportunities and foster a culture of energy efficiency and sustainability.

Acknowledgements



This paper is based on a thesis from the University of the Western Cape, South Africa. Thesis by Thembinkosi Maphosa. (2024). The financial sustainability challenges of an energy efficient intervention project in a low-income earning urban community: lessons from the Kuyasa clean development mechanism (cdm) (Doctoral dissertation, University of the Western Cape). <https://uwcscholar.uwc.ac.za/items/d25527b8-a637-41f4-803f-382bd35c92c2>

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Beyond Access: An Integrated Technological Strategy for Financial Inclusion and Competitiveness in Rural Automobile SMMEs – A Qualitative Inquiry

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Abstract

This paper challenges the prevailing techno-centric paradigm by qualitatively investigating the complex interdependencies between technology, skills, finance, and institutional support to enhance financial inclusion and competitiveness among rural automobile artisan SMMEs in South Africa's Limpopo Province. Rural automobile artisan SMMEs in Limpopo Province face a technology-competitiveness challenges, where the introduction of technology without the required skills, business acumen, and financial support leads to wasted resources, misdiagnoses, eroded customer trust, and failed competitiveness, rather than enhanced inclusion and growth.

Grounded in the Resource-Based View and the Technology-Organization-Environment framework, it employs a qualitative design, collecting data from 60 focus group discussions with artisans and stakeholders across five districts. Thematic analysis elucidated five key themes: Factor Conditions, SMME Structure and Rivalry, SMME Support, Demand Conditions, and Competitiveness. Findings reveal a profound technology adoption gap due primarily to a deep literacy chasm and absence of complementary capabilities. Participants articulated a technology-competitiveness paradox, where technology without requisite skills erodes trust and wastes resources. The study also uncovered reliance on informal finance and perceived inaccessibility of formal support. Consequently, it proposes a strategic shift to integrated interventions via a four-pillar framework: Technological Enablement, Financial Inclusion, Capacity Building, and Ecosystem Development. This necessitates bundled policy initiatives, context-specific financial products, and modular practical training. The study contributes an original, qualitatively grounded integrated framework that moves beyond access to address the technology-competitiveness paradox from the lived experiences of marginalized rural artisans.

Keywords: SMMEs, Financial inclusion, Technological adoption, Competitiveness, Integrated strategy, Rural entrepreneurship, Automobile artisans, Qualitative study.

Introduction

Small, Medium, and Micro Enterprises (SMMEs) are critical for economic growth, job creation, and poverty alleviation (Abdelwahed et al., 2023; Dvouletý & Blažková, 2021). In South Africa, they are vital for addressing inequities and enabling inclusive development (Malebana & Ndinda, 2021; Urban & Maphosa, 2022). However, rural and township SMMEs face severe constraints in



accessing formal markets, finance, and infrastructure (Chimucheka & Mandipaka, 2022; Nyathik & Suresh, 2023).

Rural automobile artisans are a key part of this informal economy, providing essential services to underserved communities (Mbokane & Pietersen, 2021; Tshikovhi & Mbewana, 2023). They operate under precarious conditions of informality, resource scarcity, and the disruptive pressure of new automotive technologies (Bhorat et al., 2022; Opeyemi, 2024). While digital tools are often promoted as a developmental panacea, evidence shows the link between technology access and competitiveness is not automatic (Adeyonu et al., 2023; Ogundana et al., 2024). Existing approaches remain fragmented, examining technology, finance, and skills in isolation rather than as interconnected systemic challenges (Ayanwale et al., 2021; Maseko & Dlamini, 2022; Ziblim et al., 2023).

This study therefore proposes and qualitatively investigates an integrated strategy that deliberately links technological adoption with financial inclusion and holistic capacity building. It argues that for technology to be truly transformative for marginalized SMMEs, it must be embedded within a supportive ecosystem that enables its effective acquisition and application. This reality is best understood through the lived experiences of the artisans themselves.

Background

The South African economy, like many in the developing world, is characterized by stark dualities: a sophisticated, globally integrated formal sector coexists with a vast, vibrant, but struggling informal sector. Rural SMMEs, which form the backbone of local economic activity and social stability in many areas, are disproportionately affected by this duality. They face profound geographic isolation, which severely limits their market access and increases transaction costs, alongside crippling infrastructural deficits in areas such as reliable electricity, high-speed internet connectivity, and paved transportation networks (Gherhes *et al.*, 2021; Mucheche *et al.*, 2023).

The automobile artisanal sector in rural Limpopo provides a poignant illustration of this struggle. These artisans offer an indispensable service, ensuring the mobility of people and goods in areas profoundly underserved by formal automotive networks. However, their operations are typified by informality, often operating from residential backyards, makeshift roadside stands, and open-air enclaves. The central thesis of this paper is that for technology to be truly transformative for marginalized SMMEs, it must be embedded within a supportive ecosystem that enables its effective acquisition, application, and commercialisation, a reality best understood through the lived experiences of the artisans themselves. This informality inherently limits their potential for growth, professionalism, safety, and, most critically, their access to formal capital, quality supply chains, and institutional support.

Problem Statement

The core problem this research addresses is the fragmented, disconnected, and often fundamentally misaligned nature of prevailing support mechanisms for these SMMEs. Policymakers, development agencies, and financial institutions frequently promote technology access as a panacea for development, launching initiatives that distribute devices or software without concurrently addressing the foundational digital and technical skills needed to use them



effectively, or the sustainable financial models required for their acquisition and maintenance (Ayanwale & Ndlovu, 2024; Mbowe & Ottih, 2023). This disconnected approach has led to a recurring and costly scenario where even when technology is introduced, it fails to translate into enhanced competitiveness or sustainable income growth, (Singh *et al.*, 2025). This misalignment is evidenced by a growing body of literature which suggests that without complementary capabilities, technology remains an underutilized asset or, worse, a liability. There is, therefore, an urgent and compelling need for a coherent, integrated strategy that treats technology not as an isolated input, but as one integral component within a broader, interconnected system of support. This system must consciously and systematically encompass tailored financial products, targeted human capability development, and a supportive institutional and physical environment. This study responds to this gap by qualitatively exploring the perspectives of artisans to develop such a holistic framework.

Research Objectives

The primary objective of this research is to develop and propose an integrated technological strategy for enhancing financial inclusion and competitiveness among rural automobile SMMEs, based on qualitative evidence. This overarching aim is operationalized through the following specific research objectives (ROs):

- To explore the lived experiences, perceptions, and challenges related to technology adoption and access to financial services among rural automobile artisans.
- To identify, from the participants' perspectives, the key factors that influence the competitiveness of these SMMEs.
- To examine the perceived interrelationships between technology access, financial inclusion, skills development, and SMME competitiveness.
- To develop a comprehensive, integrated framework that outlines the synergistic interventions required to foster sustainable growth in this sector.

1.4 Hypotheses

Central Proposition:

H1: An integrated strategy that simultaneously addresses technological enablement, financial inclusion, capacity building, and ecosystem development is perceived by rural automobile SMMEs as a more effective and viable pathway to enhancing their competitiveness and sustainability than isolated, techno-centric interventions.

Exploratory Propositions (Derived from research themes):

H1a: Technology Adoption & Skills (The Technology-Competitiveness Paradox)

The connection between technology adoption and business competitiveness for rural artisans is not direct but is critically mediated by their access to complementary technical and digital skills. The lived experience of artisans suggests that in the absence of these skills, technology adoption can undermine competitiveness through misdiagnosis, wasted resources, and eroded customer trust.



H1b: Financial Inclusion & Technology Investment

The ability of rural SMMEs to invest in and adopt productivity-enhancing technologies is shaped by their level of financial inclusion. Access to tailored formal financial products (e.g., leasing, micro-loans) is a key condition that enables this investment and facilitates a transition away from reliance on informal finance.

H1c: Capacity Building & Resource Orchestration

Targeted capacity building that combines technical upskilling with business management training enhances the ability of SMMEs to effectively orchestrate and integrate technological and financial resources into their operations, as understood through their narratives of navigating business challenges.

H1d: Ecosystem Support & Formality

A supportive institutional ecosystem (e.g., shared workspaces, streamlined registration, market linkages) influences the pathways to and perceptions of formalization for rural SMMEs. This support is understood by artisans as fundamental to improving their professional reputation, customer trust, and, consequently, their market access and competitiveness.

P1e: Nature of Entrepreneurial Challenges

Rural automobile artisans experience and articulate the challenges of technology access, financial constraints, skills gaps, and an unsupportive business environment as deeply interconnected and systemic. This perceived interconnectedness forms the basis of their view that holistic, rather than siloed, interventions are necessary.

Literature Review

8.1 The plight of rural SMMEs and the automobile artisan sector

Rural SMMEs in the Global South operate in an environment of profound resource scarcity and institutional void. Geographic isolation is a primary constraint, limiting their access to larger customer bases, reliable suppliers, and industry information, while simultaneously increasing the costs of transportation and communication (Gherhes *et al.*, 2021; Mucheche *et al.*, 2023). This is compounded by profound infrastructural deficits. The lack of reliable electricity disrupts operations, the absence of affordable and high-speed internet impedes access to online information and digital tools, and poor road networks increase the cost and time of receiving parts and serving customers (Tanwar & Bhardwaj, 2022; Wu *et al.*, 2023). This environment of scarcity necessitates innovative and context-specific survival strategies, a concept often referred to as entrepreneurial bricolage (Khan *et al.*, 2023; Siyao, 2024).

The South African rural SMME landscape mirrors these global trends with acute severity. Studies consistently highlight a trifecta of impediments to growth: critical skills shortages, severely limited access to formal credit and financial products, and inadequate or misdirected institutional support from government and development agencies (Chimucheka, 2021; Mashau & Kaseeram, 2024). The automobile artisan sector is deeply embedded within this challenging context. Studies specific to this sector highlight its undeniable socio-economic importance for rural mobility and



livelihood creation, but also its profound vulnerability (Mbokane & Pietersen, 2021; Tshikovhi & Mbewana, 2023).

8.2 Technology adoption, the digital divide, and competitiveness

The discourse on technology adoption in SMMEs has long been guided by models like the Technology Acceptance Model (TAM). However, these models, often developed in Western, formalised contexts, frequently underplay the acute resource and institutional constraints that are paramount in rural settings of the Global South. For rural SMMEs, the barriers to adoption are more fundamental and severe than mere perceptions. They include the prohibitively high cost of acquiring and maintaining hardware and software (Ngwenya & Pelser, 2022), a critical lack of digital literacy and technical skills to utilise even basic applications (Adebisi, 2023; Lekhanya, 2021), and a perceived irrelevance of complex digital tools to immediate, day-to-day survival needs (Ayanwale & Ndlovu, 2024; Mbowa & Ottih, 2023).

This confluence of barriers creates a significant and persistent digital divide, excluding rural entrepreneurs from the productivity gains that technology can enable. There is robust evidence that technology adoption *can* lead to significant gains in productivity, customer reach, operational efficiency, and ultimately, profitability (Polas *et al.*, 2023; Satyro *et al.*, 2023). However, the literature increasingly cautions that its mere presence is insufficient. The link between access and competitiveness is not automatic or linear; it is critically mediated by the entrepreneur's absorptive capacity, their ability to recognize, assimilate, and apply the technology to commercial ends.

8.3 Financial inclusion beyond credit

A comprehensive understanding of financial inclusion for SMMEs extends far beyond simple access to credit. It encompasses a full suite of financial services tailored to their needs, including transaction accounts, savings vehicles, insurance products (e.g., for tools, premises, or liability), digital payment systems, and tailored investment or leasing products (Beck & Cull, 2023; Demirgüç-Kunt *et al.*, 2022). Rural automobile artisans are typically on the margins of this financial ecosystem, being either unserved or underserved. They rely heavily on personal savings and informal lending circles (such as *stokvels* in South Africa) due to a lack of acceptable collateral, non-existent or poor credit histories, and the perceived high risk and administrative cost they pose to formal financial institutions (Maseko & Dlamini, 2022; Ngorora & Mago, 2023).

This heavy reliance on informal finance severely limits their ability to make productivity-enhancing investments, such as in advanced diagnostic equipment or inventory management software. In recent years, innovative financial mechanisms have emerged as potential solutions to bridge this gap. These include mobile money platforms that facilitate easy payments and savings, fintech-enabled microloans that use alternative data for credit scoring, and technology-leasing models that reduce upfront capital requirements (Dranev *et al.*, 2023; Ozili, 2024).

8.4 Toward integrated support frameworks: The theoretical foundation



A growing body of literature advocates for a systemic and integrated approach to SMME development, moving decisively away from fragmented, piecemeal interventions (Cant *et al.*, 2023; Urban, 2022). This perspective is powerfully underpinned by two complementary theoretical frameworks that justify and guide this study's integrated approach.

The Resource-Based View (RBV) of the firm posits that sustainable competitive advantage is derived not from common, easily acquired resources, but from the unique, valuable, rare, and difficult-to-imitate bundling of a firm's tangible and intangible resources (Barney, 2018). For an automobile artisan, this implies that competitive advantage does not come merely from possessing a sophisticated diagnostic tool (a tangible resource), but from the *orchestration* of that tool with the artisan's advanced technical skills to interpret its data (an intangible human resource) *and* their business acumen to effectively market, price, and deliver the enhanced service (another intangible resource). Simultaneously, the Technology-Organization-Environment (TOE) framework provides a useful lens at the firm level for understanding technological innovation. It posits that the adoption and implementation of new technologies are influenced by a confluence of three contexts: the *technological context* (the available internal and external technologies), the *organizational context* (firm size, structure, slack resources, and employee skills), and the *external environmental context* (industry characteristics, regulatory landscape, and support from government and institutions) (Baker, 2021; Oliveira & Martins, 2021).

An integrated strategy is, therefore, a theoretical imperative. It seeks to build the valuable and complementary resource bundles advocated by the RBV by simultaneously addressing the technological, organizational, and environmental contexts highlighted by the TOE framework. This study uses qualitative inquiry to understand how these contexts are experienced by artisans, thereby informing a grounded, integrated framework.

Research design and methodology

This chapter outlines the philosophical and practical blueprint for the study. It details the research paradigm, design, approach, method, and specific procedures employed for sampling, data collection, and analysis, providing a clear rationale for each decision to ensure the rigour and trustworthiness of the inquiry.

3.1 Research paradigm and design

This study was grounded in phenomenology research paradigm. Phenomenology was selected because of its focus on exploring people's subjective experiences and perceptions. It's a qualitative research approach that aims to gain a deeper understanding of how individuals experience and interpret the world around them. (Creswell & Poth, 2018). By using phenomenology, researchers can gain a richer understanding of complex issues and develop theories that are grounded in people's lived experiences. For this study, which aims to develop an integrated strategy for SMME development, phenomenology justified the use of methods that would best capture the lived realities and practical insights of the participants.

A qualitative research design was employed. This design was chosen to facilitate a deep, contextualised, and nuanced understanding of the complex interdependencies between technology, finance, skills, and competitiveness from the perspectives of the artisans themselves.



The qualitative design enabled the exploration of lived experiences, perceptions, and the underlying reasons for the identified challenges, which was essential for achieving the research objectives, particularly the development of a context-rich integrated framework (RO4).

3.2. Research approach

This study utilised a qualitative research approach. A qualitative approach was deemed most appropriate as the research sought to answer "how" and "why" questions about a complex, socially situated phenomenon (Saunders et al., 2023). The objective was not to quantify relationships but to generate rich, narrative data that could provide deep insights into the participants' world. This approach allowed for flexibility and responsiveness during data collection, enabling the researcher to probe emergent themes and capture the depth and complexity of the artisans' experiences, which a quantitative approach would be unable to achieve.

3.3. Research method

The primary research method was focus group discussions (FGDs). This method was selected as it capitalizes on group dynamics to generate data through interaction and the sharing of ideas among participants (Kitzinger, 1995). For this study, FGDs were ideal for uncovering collective views, common experiences, and shared challenges within the community of automobile artisans. The interactive nature of FGDs allowed participants to build upon each other's responses, leading to a more comprehensive and nuanced understanding of the research problem than individual interviews might have provided.

3.4. Population and Sample

The study population consisted of automobile artisans and key institutional stakeholders (such as Local Economic Development managers and business development officers) operating within the five district municipalities of Limpopo Province, South Africa. A purposive sampling technique was employed to select participants. This non-probability technique was chosen to deliberately identify and recruit information-rich cases that could provide deep insights into the phenomenon under study (Etikan *et al.*, 2016). The sample intentionally included a mix of automobile artisans of varying ages, business maturity, and specializations, alongside institutional stakeholders. This ensured data triangulation and provided a multi-faceted perspective on the challenges and potential solutions. The final sample consisted of 60 participants, with 12 participants taking part in each of the five FGDs (one per district municipality). This sample size was sufficient to reach data saturation, where no new thematic information was emerging from the discussions.

3.5. Research instrument

The primary research instrument was a semi-structured interview guide. This guide contained a set of open-ended questions and prompts that ensured key topics were covered across all focus groups while allowing for flexibility and probing based on the flow of the discussion. The guide was designed to explore participants:

- Experiences with and perceptions of technology adoption.
- Understanding of and access to financial services.



- Perceived technical and business skill gaps.
- Views on existing institutional support systems.
- Ideas for effective, integrated interventions.

3.6. Data collection

Data collection for this study was conducted in two distinct phases: a qualitative phase employing focus group discussions, followed by a quantitative phase utilizing a structured questionnaire survey. This sequential mixed-methods approach was designed to first gain in-depth contextual insights from participants, and subsequently to measure the prevalence and distribution of key phenomena across a larger population sample within Limpopo Province.

3.6.1. Qualitative Phase: Focus Group Discussions

The qualitative data were gathered through a series of five focus group discussions (FGDs), conducted one in each of Limpopo's five district municipalities: Capricorn, Sekhukhune, Waterberg, Mopani, and Vhembe. This district-wise distribution was intentional, ensuring that the diverse socio-economic, cultural, and agricultural conditions across the province were adequately represented in the exploratory phase of the research.

Participants for the FGDs were selected using a purposive sampling strategy. This non-probabilistic approach was employed to deliberately identify and recruit individuals who possessed specific knowledge, experience, and relevance to the research topic. The criteria for selection included active involvement in smallholder farming, residency within the respective district for a minimum period, and willingness to share their experiences openly. Each focus group was composed of 12 participants, resulting in a total of 60 participants across all five districts. This group size was deemed optimal to facilitate dynamic discussion while ensuring that every participant had an adequate opportunity to contribute.

The FGDs were conducted over a five-month period, from December 2023 to April 2024. Each session lasted approximately 90 to 120 minutes, allowing sufficient time to explore the discussion guide thoroughly while remaining sensitive to participants' time constraints. The discussions were facilitated by a trained moderator, assisted by a note-taker, and were conducted in local languages familiar to the participants to encourage free and open expression. Crucially, prior to the commencement of each FGD, informed consent was obtained from all participants. This consent explicitly included permission for audio recording. With this permission secured, all sessions were audio-recorded to ensure the complete and accurate capture of all dialogue, nuances, and interactions. Following the fieldwork, each audio recording was transcribed verbatim. This process produced a comprehensive textual dataset that served as the foundation for the qualitative analysis. In addition to audio recordings, detailed field notes were taken during and immediately after each session. These notes captured non-verbal cues, such as body language and group dynamics, as well as contextual observations about the setting and any unforeseen events, providing a richer layer of data to complement the transcripts.

3.7. Ethical Considerations



The research adhered to strict ethical principles as outlined in the protocol approved by the relevant ethics committee of Northwest University. Informed consent was obtained from all participants prior to their involvement. Participants were explicitly informed about the purpose of the study, the voluntary nature of their participation, and their right to withdraw at any time without penalty. To ensure confidentiality and anonymity, all identifying information was removed from the transcripts. Participants were assigned pseudonyms during the analysis and reporting phases, and the data is presented in an aggregated format to prevent the identification of any individual or specific business.

Results and Findings

The thematic analysis of the focus group discussions yielded five central themes that comprehensively capture the challenges and dynamics faced by rural automobile artisans in Limpopo. These themes provide the qualitative evidence base for understanding the technology-competitiveness paradox and formulating an integrated response.

4.1 Theme 1: Factor Conditions

This theme encompassed the fundamental resources perceived as essential for successful operations. Participants consistently highlighted the absence of these factors. A primary concern was the lack of proper operational spaces, which directly impacted their professional image and customer trust. As one participant noted, *"If we can have a proper designated place to operate in...it will help us in being perceived as professionals by our clients and potential clients."* [Participant 4]. Beyond physical infrastructure, the need for continuous education and upskilling was strongly emphasized. Participants linked technological literacy directly to competitiveness: *"If we can receive some sort of support through education and upskilling it will help us in use of technology and competitiveness"* [Participant 6]. Access to finance was repeatedly cited as a critical barrier to acquiring the tools needed to compete, with one artisan stating, *"If we can get financial assistance, we will be in a better position to compete because we can buy latest equipment..."* [Participant 9]. This theme underscores that competitive potential is stifled by a deficit in basic factor conditions, location, skills, and capital.

4.2 Theme 2: SMME Structure and Rivalry

This theme revolved around the internal organization of the enterprises and the nature of competition within the sector. The informality and resource scarcity forced artisans into inefficient operational structures. A participant explained, *"As business owners with very limited funds, you find that we are everything in one because we cannot afford to have a structure in our business."* [Participant 16]. This lack of structure impeded specialization and efficiency. Furthermore, regulatory frameworks were perceived as punitive rather than supportive. *"The regulations are negatively affecting our operations because in order for to comply with some of them it costs money we do not have."* [Participant 22]. This created an uneven playing field, as *"The affluent workshops are more competitive because they are privileged with money and they are perceived in the market as more professional than those who operate on the side of the road."* The theme highlights how informality and a harsh competitive environment perpetuate a cycle of disadvantage for these micro-enterprises.



4.3 Theme 3: SMME Support

This theme captured the participants' experiences with and perceptions of institutional support systems. A stark gap was identified between the need for continuous skill development and the reality of its accessibility. *"We would love to get continuous training, but it is very expensive."* [Participant 28]. Despite technological challenges, many artisans exhibited resilience, claiming, *"We are relatively affected by technology developments, but we still are able to provide quality service to our clients."* [Participant 29]. However, this resilience was often undermined by a lack of customer trust, intrinsically linked to their informal status: *"Customers who drive new models do not trust us who work from the back of the yards..."* [Participant 28]. This theme reveals that existing support mechanisms are either inaccessible or misaligned with the realities of the artisans, failing to address key constraints like training costs and legitimacy.

4.4 Theme 4: Demand Conditions

This theme focused on customer perceptions, expectations, and their influence on business operations. Participants reported that their operational location and informal appearance directly impacted their pricing power and customer willingness to pay. *"Because of where we work from most customers do not want to pay what we charge them...."* This indicates that demand is not just a function of service quality but is significantly mediated by perceptions of professionalism. To cope with technological challenges, collaboration emerged as a key strategy: *"We do our best to cope with our challenges especially the technological ones by collaborating with others..."* [Participant 44]. This theme demonstrates that market demand is fragile and that artisans must navigate customer biases, which are often detached from their actual technical competence.

4.5 Theme 5: Competitiveness

The final theme synthesized what the artisans believed was required to achieve and sustain competitiveness in their evolving market. Central to this was the recognition that technology adoption is imperative for gaining customer trust and remaining relevant. *"To win trust from our customers we need to employ or partner with young people who will adapt quickly to new technologies...."* [Participant 40]. However, the ability to leverage technology for marketing and growth was constrained by financial resources, leading to a reliance on *"word of mouth..."* [Participant 56]. This theme clearly articulates the dilemma facing these SMMEs: they understand the need to modernize and adopt technology to be competitive, but they lack the financial and human capital to do so effectively. This directly illustrates the core argument that technology, without the complementary capabilities to leverage it, cannot unlock competitiveness and may even heighten the sense of disadvantage.

4.6 Discussion: The Technology-Competitiveness paradox through a qualitative Lens

The five themes collectively provide a rich, narrative explanation for the technology-competitiveness paradox. The findings illustrate that the mere presence of technology is insufficient and can be detrimental. The qualitative data elucidates the mechanism behind this paradox: technology without the complementary human capital (technical and digital skills) and



organizational resources (business processes, financial capital, and formal structures) leads to negative outcomes. Participants hinted at experiences of misdiagnoses with unfamiliar tools, wasted scarce resources on equipment they could not fully utilize, and ultimately, damaged customer trust when they failed to deliver on the promise of new technology.

This finding resonates powerfully with the Resource-Based View (Barney, 2018; Teece, 2021). The participants' narratives confirm that the technology itself is not a valuable or rare resource. Competitive advantage is only created through the effective orchestration of technology with advanced skills, financial stability, and efficient business processes, the valuable, intangible resource bundles. Without this orchestration, technology actively erodes competitiveness by increasing complexity and cost without delivering a commensurate return. The artisans' own emphasis on customer experience, trust, and convenience as the true drivers of competitiveness reinforces that their business is built on relational capital, which can be easily undermined by poorly integrated technology. The TOE framework is also affirmed, as the barriers exist simultaneously in the technological (cost, complexity), organizational (skills, structure), and environmental (regulation, customer perception, lack of support) contexts.

Managerial Implications

Based on the empirical themes and their theoretical interpretation, we propose a comprehensive, integrated framework built on four interdependent pillars. This framework, summarised in Table 1, directly addresses RO4 and is designed to create the synergistic effects necessary to break the cycle of informality and low competitiveness by responding directly to the voiced needs of the artisans.

Table 1: Qualitatively-Informed Integrated Strategy Framework

Strategic Pillar	Key Interventions	Theoretical Alignment & Expected Outcomes
1. Technological Enablement	Develop and promote low-cost, rugged, and intuitive digital tools (e.g., mobile-based diagnostic apps that function offline); introduce basic automation for inventory and customer management.	TOE Framework: Improves the technological context by providing fit-for-purpose tools, enhancing perceived ease of use and usefulness. Outcome: Improved diagnostic accuracy, operational efficiency, and enhanced service quality, directly addressing the factor conditions gap.
2. Financial Inclusion	Create technology-specific grants and "micro-leasing" options for equipment; partner with fintechs to develop savings-linked incentives and	RBV: Provides the tangible financial resources needed to acquire and maintain technological tools, making them accessible.



Strategic Pillar	Key Interventions	Theoretical Alignment & Expected Outcomes
	alternative credit-scoring models using mobile data.	Outcome: Reduced upfront cost barriers, increased technology adoption, and better cash flow management, overcoming the financial constraints identified by participants.
3. Capacity Building	Forge formal partnerships with TVET colleges for certified, short-cycle training; establish peer-to-peer mentorship programs; deliver foundational business skills training in marketing, pricing, and finance.	Human Capital Theory/RBV: Develops the intangible human resources (specialised skills and knowledge) required to exploit technological and financial resources effectively. Outcome: Enhanced technical, digital, and managerial capabilities, leading to better resource orchestration and addressing the critical skills deficit voiced in the themes.
4. Ecosystem Development	Municipalities to facilitate established, formal, shared-workspace "artisan clusters" with basic infrastructure (power, internet, security); streamline business registration; create platforms for market linkages with parts suppliers and insurance companies.	Institutional Theory/TOE: Creates a supportive and enabling external environment that reduces transaction costs, legitimizes informal businesses, and fosters collective efficiency. Outcome: Improved professionalism, economies of scale, better market access, and increased customer trust, directly responding to themes of structure, support, and demand conditions.

5.1 Implications for Stakeholders

- For Policymakers and Government Agencies: The era of siloed interventions must end. Policy must shift towards designing and funding *coordinated, "bundled" initiatives* that combine technology provision with mandatory training and infrastructure support, as isolated solutions have proven ineffective and potentially harmful.
- For Financial Institutions and Development Finance Institutions (DFIs): There is an urgent need for *context-specific, design-thinking-led financial products*. Instead of offering generic small business loans, DFIs and fintech partners should design "technology-



acquisition microloans," "tool-leasing schemes," and "savings-linked incentive programs" that respond to the specific financial behaviours and constraints described by the artisans.

- For Educational and Training Bodies (e.g., TVET Colleges): There is a critical opportunity to bridge the chasm between formal education and the dynamic needs of the informal sector. TVET colleges can strategically reposition themselves by offering *short-cycle, modular, certified, and mobile-friendly training programs* delivered in the evenings or on weekends, covering both technical and business management skills, exactly as requested by the participants.

Conclusions and Future Research

This qualitative study demonstrates conclusively that the path to sustainable competitiveness for rural automobile SMMEs lies not in isolated, siloed interventions but in a consciously designed synergistic strategy that integrates technology, finance, skills, and institutional support. The voices of the artisans provide powerful evidence of the technology-competitiveness paradox, serving as a stark warning against simplistic, techno-centric solutions that ignore the foundational capabilities and the complex reality of the enterprise. The proposed integrated framework, grounded in the complementary theories of the Resource-Based View and the Technology-Organization-Environment framework and informed by the lived experiences of the artisans, offers an actionable and theoretically sound roadmap. It emphasizes that economic value and competitive advantage are created not by resources in isolation, but by their strategic bundling and orchestration within a supportive ecosystem. By addressing these dimensions collectively and systemically, stakeholders can move beyond merely providing access to enabling meaningful empowerment. This approach holds the promise of unlocking the latent potential of these vital enterprises, fostering not only individual business growth and resilience but also contributing to broader economic development and social inclusion in marginalized rural communities across the Global South.



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Consumer Perceptions of Recycled Cotton Fabric in Support of Advancing Sustainable Development Goal 12

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Abstract

South Africa's fashion industry continues to grow with a balance of environmental responsibility and creative expression; however, fast-fashion practices hinder the progress toward circular production systems. Within this context, luxurious sustainable garments made from recycled cotton emerge as a viable solution to reduce textile waste and advance Sustainable Development Goal 12 (SDG 12): Responsible Consumption and Production. However, consumer perceptions and understanding of recycled cotton and the process of influencing its sustainable adoption remain limited. This study explored how individuals perceive recycled cotton fabric and the extent to which their perceptions support sustainable consumption behaviour. This study adopted the Value-Belief-Norm (VBN) theory and the Theory of Planned Behaviour (TPB) as the theoretical framework. An exploratory research design was applied with an interpretivist philosophical standpoint. A qualitative research approach was adopted, while data was collected from ten (10) purposively selected participants, comprising of postgraduate students and educators from a South African private higher education institution. An interview guide was used to collect data through semi-structured interviews. Thematic analysis identified several key themes, namely: reduction in pollution, avoiding landfills, promoting circularity, rejection of fast fashion, education, trust, variability and cost implications of slow fashion. The results indicate that participants' perceptions about recycled cotton fabric are anchored on environmental textile benefits, knowledge shapes sustainability choices, trust, variability and cost implications are barriers for utilising recycled cotton fabric. The study concludes with applicable recommendations and future study directions.

Keywords: consumer perceptions, circular economy, fast fashion, recycled cotton, sustainable development goal 12, sustainable fashion

Introduction

1.1 Background

Despite studies, including those by Alcantara et al. (2024) as well as Juanga-Labayen et al. (2022), that have explored the technical processes of textile waste management, such as reduction, reuse, and recycling strategies, there is a significant research gap in South Africa regarding consumer perceptions of recycled cotton fabric, in general. Consumer perceptions refer to the way individuals interpret, evaluate, respond to product information based on their values, and experiences toward sustainable fashion (Y. Hong et al., 2024). The extant studies mainly



provide production-side frameworks, while neglecting the psychological, cognitive, cultural, and educational elements that affect sustainable consumption.

Resultantly, South Africa has initiated a shift from the linear paradigm of produce, consume, and dispose towards a circular economy that promotes sustained product utilisation and recycling (United Nations in South Africa, 2022), indicating a promising use of recovered cotton fabric. Recycled cotton fabric refers to fibres reclaimed from pre-consumer and post-consumer textile waste that are mechanically or chemically processed into new yarn or fabric, reducing dependence on virgin fibres and conserving natural resources (Arafat & Uddin, 2022; UNEP, 2025). Foroozesh (2021) points out that several clothing items are acquired with no comprehension of their material origins, hindering customers' ability to connect meaningfully with sustainable alternatives. This research addresses the gap in developing countries, customer views, and attitudes when it comes to the continuous use of recycled cotton fabric. This study aims to explore the perspectives of fashion students and educators, who are key figures in influencing future industry standards and practices (Arafat & Uddin, 2022). In addition, Arafat and Uddin (2022) emphasise the significance of this effort, observing that consumers' uncertainty about the quality, durability, and adoption of recycled fabrics remains a substantial obstacle to their wider low continuance use.

The results from this study may facilitate the creation of more impactful sustainability initiatives and contribute to more focused curriculum development in fashion education and clothing productivity infused with sustainability best practices. This initiative is consistent with the global objective of Sustainable Development Goal 12 (SDG 12): Responsible Consumption and Production, which aims to ensure sustainable management of natural resources and promotion of responsible consumption and production patterns (United Nations, 2023) are achieved by 2030. SDG 12 advances sustainable fashion by promoting circularity, transparency, and responsible sourcing, aligning with consumer awareness and sustainable lifestyle changes (Castellano et al., 2024). Despite South Africa's initial progress in embracing circular economy ideas, a more profound comprehension of public and professional perceptions of recycled materials might provide novel insights for future decision-making in the fashion industry. Hence the research question guiding this study is:

How do consumer perceptions regarding the use of recycled cotton fabric contribute to the advancement of Sustainable Development Goal 12?

1.2 Problem Statement

The United Nations defines sustainability as development that meets the needs of the present without compromising the ability of future generations to meet their own (Dixit & Chaudhary, 2020). This principle forms the foundation for the Sustainable Development Goals (SDGs), particularly SDG 12, which promotes responsible consumption and production. The fashion and textile industry remains one of the most environmentally damaging sectors globally, producing nearly 92 trillion tonnes of waste annually and contributing to severe ecological degradation (UNEP, 2025). The fashion industry further accounts for 10% of global carbon emissions and 20% of global water pollution, with 85% of textiles ending up in landfills each year (Bailey et al., 2022; Maiti, 2025). Cotton is one of the most widely used natural fibres, contributing to approximately



25% of total fibre consumption worldwide, exacerbating water depletion and chemical pollution (Ragab et al., 2024).

On the other hand, recycled cotton has emerged as a sustainable textile alternative that aligns with the principles of SDG 12 by promoting responsible production and consumption practices. Derived from post-consumer or pre-consumer textile waste. Recycled cotton significantly reduces resource consumption, carbon emissions, and landfill waste (Nxtile, 2024). Despite these advantages, only 1% of cotton textiles in South Africa are recycled into the supply chain (ENSafrica, 2024), reflecting limited progress toward circular fashion practices. While international studies have focused on the technological and industrial processes of recycling (Alcantara et al., 2024), thus remains a gap in understanding consumer perceptions, that is, how individuals interpret, evaluate, and act toward sustainable recycled cotton fabric (Kim et al., 2021).

The lack of consumer awareness surrounding recycled fabrics and their environmental benefits contributes to slow adoption rates (Monyaki & Cilliers, 2023). This study addresses this problem by exploring how fashion students and educators perceive and engage with recycled cotton fabric, given their role in shaping the future of sustainable fashion. The research seeks to explore the cognitive, cultural, and moral factors impacting their perceptions and to identify barriers to accepting sustainable fashion practices. Addressing the prevailing issues contributes both theoretically, by filling the knowledge gap around sustainable consumption behaviour, and practically, by offering recommendations to support the integration of circular textile practices into fashion education and industry operations. Ultimately, the study aligns with SDG 12's global vision of reducing waste and fostering conscious, long-term sustainable consumption within South Africa's fashion landscape.

1.3 Research Objectives

- RO1: To explore how the use of recycled cotton in fashion contributes to achieving sustainable consumption linked to SDG 12.
- RO2: To identify how consumer perceptions impact consumer attitudes towards sustainable slow fashion.
- RO3: To assess the impact of consumer knowledge of SDG 12 on sustainable fashion purchase decisions.
- RO4: To identify the key challenges that prevent consumers from using recycled cotton-based apparel that aligns with responsible consumption and production.

1.4. Research Questions

- Q1: How can the use of recycled cotton in fashion contribute to achieving sustainable consumption linked to SDG 12?
- Q2: How do consumer perceptions impact consumer attitudes towards sustainable slow fashion?
- Q3: How does consumer knowledge of SDG 12 impact sustainable fashion purchase decisions?



- Q4: What existing challenges prevent consumers from using recycled cotton-based apparel that aligns with responsible consumption and production?

Literature Review

2.1 Sustainability in fashion: environmental, social, and economic

The United Nations' 2030 Agenda for Sustainable Development highlights the convergence of environmental, social, and economic objectives (Jha, 2018). Among the seventeen SDGs, SDG 12 is primarily concerned with enhancing resource efficiency, eliminating waste, and promoting sustainable consumer habits. These goals are relevant to the fashion industry, since recycled cotton exhibits innovation that tackles both environmental, social and economic problems (Castellano et al., 2024).

The sustainability framework is usually portrayed as three interrelated pillars. Figure 1 presents the pillars.

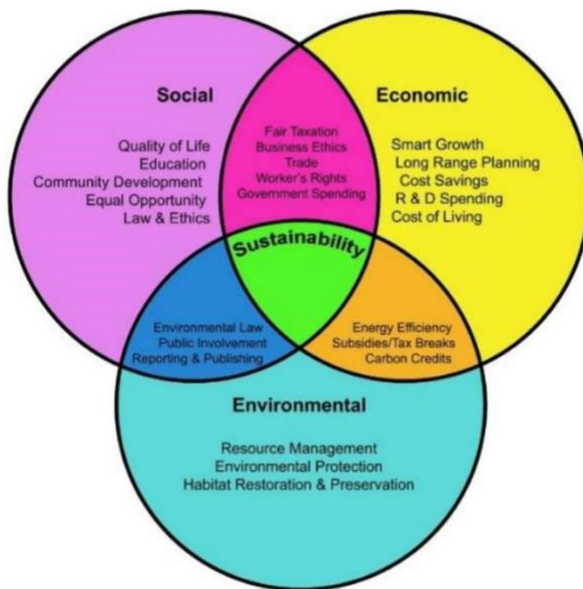


Figure 1: The three main pillars of sustainability

Source: Joyram (2022)

As shown in Figure 1, the environmental pillar aims to mitigate pollution and resource depletion (Mensah, 2019). The social pillar encourages justice and inclusion through ethical sourcing and consumer education (K. Wang et al., 2024). The economic pillar fosters resource efficiency and long-term economic prosperity (Dalampira & Nastis, 2020). Despite their general complementarity, conflicts exist between them. For example, Simon (2023) observes that economic considerations usually trump environmental aims in underdeveloped nations, impeding progress towards sustainability. Though recycled cotton is not only an eco-friendly material, but also a vehicle for social equity and economic sustainability.



2.2 The global fashion industry's impact on the environment

The global fashion industry contributes about 10% of carbon dioxide emissions, making it one of the most resource-intensive sectors worldwide (Shedlock & Feldstein, 2023). Despite the growing calls for sustainability improvement, only 25% of clothing is recycled, with the remainder entering landfills and incineration (Juanga-Labayen et al., 2022). A landfill is a location where waste items are buried (UNEP, 2025). High-income regions such as Europe and North America are particularly responsible for overproduction and textile waste, largely driven by the fast fashion business model (United Nations Statistics Division, 2023). In Europe, approximately 4 million tons of textiles are discarded annually, with less than 30% collected for recycling (European Environment Agency, 2022). Similarly, in the United States, more than 11 million tons of textiles enter landfills each year, making it one of the largest generators of clothing waste globally (United States Environmental Protection Agency, 2023). In Asia, rapid industrialisation in countries such as China and Bangladesh has intensified environmental pressures, with significant water pollution and carbon emissions linked to large-scale textile production (Remy et al., 2016).

These global challenges highlight the urgency of adopting sustainable materials such as recycled cotton, yet the dynamics of textile waste and sustainability take on distinct characteristics in Africa, which is discussed further in the following section.

2.3 The African fashion industry's impact on the environment

Rising urbanisation and the imports of fast fashion have increased waste issues across the continent. In Ghana, for example, the Kantamanto market receives thousands of tons of second-hand clothing from Europe and North America each week, with over 40% ending up producing major landfill and water pollution problems (Acquaye et al., 2023). Similarly, countries such as Kenya and Nigeria are witnessing an influx of low-quality fast fashion items that cannot be reused or recycled, placing further strain on already limited African waste management systems (Andreadakis & Owusu-Wiredu, 2023). These patterns show how Africa acts as both a client and a dumping ground for unsustainable fashion.

Despite the prevailing issues, African nations are exploring other techniques of sustainability. Starting with Rwanda's 2016 prohibition on importing old clothing has been a political attempt to reduce the country's reliance on international textile waste. Research also reveals that the nation struggles to recycle its own fashion waste (Boykoff et al., 2021). (Agarwal et al., 2023) claim that the African Continental Free Trade Area (AfCFTA) and other regional measures aim to enhance African sustainable textile production. These activities also provide chances to grow recycling businesses and local design economies (UNECA, 2022). However, implementation remains uneven, with most African nations still grappling with underdeveloped textile recycling infrastructures. This underscores the need to explore South Africa's role, as the continent's key fashion market, in encouraging sustainable consumption through understanding consumer attitudes towards recycled cotton.

2.4 The South African fashion industry's impact on the environment

In South Africa, landfill textile waste is one of the most apparent environmental repercussions of the fashion industry because it demonstrates the system's reliance on a linear production model,



in which clothes are created, used, and discarded without being reintegrated into circular processes. According to Green Cape (2023), approximately 22% of cotton produced in South Africa ends up as waste, with just 1% recycled into useful textiles. This disparity highlights the lack of circularity in the country's fibre and textile value chain. Most of the wasted apparel ends up in landfills, where it adds to growing waste and puts further strain on already limited waste-management infrastructure (Govender et al., 2023).

According to Govender et al. (2023) South Africa's modest progress towards circularity is hampered by structural impediments such as undeveloped waste-sorting systems, insufficient textile recycling facilities, and a lack of investment in fibre-recovery technologies. Imported low-quality fast-fashion items and second-hand apparel exacerbate the status quo. Andreadakis and Owusu-Wiredu (2023) point out that much of clothing, made of mixed fibre, cannot be recycled locally and consequently ends up in landfills.

The Department of Forestry, Fisheries, and the Environment (2024) is concerned about the growing landfill dependence on lax implementation of extended producer responsibility (EPR) legislation, little industry engagement, and low consumer knowledge of textile disposal. The increasing amount of textile waste in landfills highlights the environmental cost of South Africa's fast-fashion industry, which is still misaligned with SDG 12. To address this growing environmental concern, we must understand consumer perceptions regarding recycling cotton best practices, improve circular-economy infrastructure, increase production responsibility, and raise consumer knowledge of sustainable cotton garment lifespan.

2.5 Debates on sustainable fashion

Despite the emphasis on recycling and circularity, there is debate about whether these practices are sufficient. Gojic and Bukhonka (2023) argue that recycling reduces waste and provides practical solutions. Whereas Juanga-Labayen et al. (2022) stipulate that recycling itself requires significant energy and resources, questioning its net benefits. Moreover, Mandarić et al. (2022) argue that sustainable fashion often excludes lower-income consumers, reinforcing inequalities. In contrast, PwC (2022) purports that global brands are beginning to integrate sustainability due to consumer demand, suggesting growing mainstream acceptance. These debates highlight the contested nature of sustainable fashion and show why a study like this nature, focused on consumer perceptions, is imperative to understand its practical relevance.

2.6 Theoretical framework

Theoretical frameworks connect the research to existing theories, concepts, and empirical knowledge, thereby ensuring that new insights are anchored within broader academic discourse. Grant and Osanloo (2014) describe a theoretical framework as the “blueprint” of a study, an organising structure that shapes how the researcher interprets findings, identifies relationships, and situates results within established theory. In qualitative research, it directs the interpretation of data by connecting participants' experiences to pertinent conceptual themes (Creswell & Poth, 2016). This study was underpinned by the Theory of Planned Behaviour (TPB) as well as the Value Belief Norm (VBN) Theory.

2.6.1 Theory of Planned Behaviour



Icek Ajzen established TPB in 1985 and maintains that individuals are more inclined to participate in an activity when they anticipate doing so and believe they control the outcome (Khanam & Nabi, 2025). TPB suggests that consumers with positive attitudes towards eco-friendly clothing, who perceive social approval for their choices and believe they can act, are more likely to buy sustainable products like recycled cotton garments (Rozenkowska, 2023). Figure 2 presents the original TPB and its related constructs.

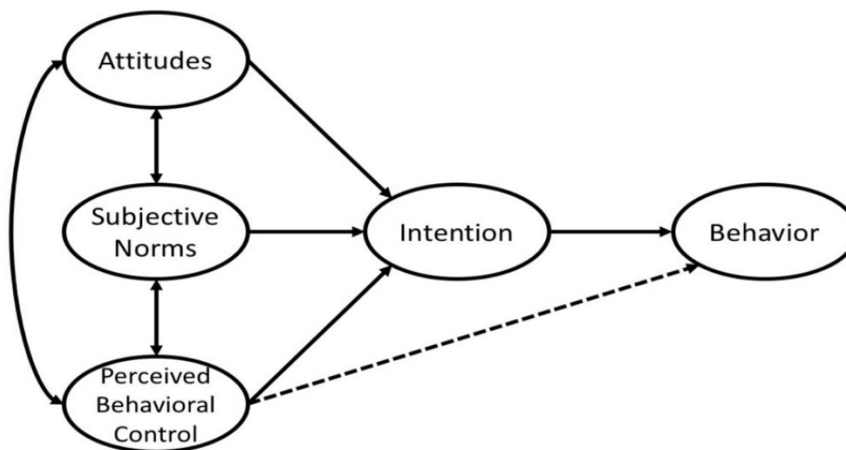


Figure 2: The theory of Planned Behaviour

Source: *Rozenkowska (2023)*

This study draws on TPB to explore the connection between how consumers perceive sustainability and how these perceptions shape their sustainable fashion behaviour. Yet, the framework does not fully capture the emotional and cultural dimensions of fashion. Clothing decisions are rarely purely rational; they are tied to identity, impulse, and personal expression (Jacobs et al., 2020). In South Africa, additional barriers such as affordability and limited access to sustainable options further complicate consumer choices (Magwegwe & Shaik, 2024). Similar patterns have been observed in studies from Asia, Europe, and South America, where positive attitudes toward sustainability often clash with everyday financial realities and systemic limitations (Jacobs et al., 2020; Kumar et al., 2021).

2.6.2 Value Belief Norm (VBN) Theory

The VBN theory, developed by Paul Stern in the 2000s, emphasises how values, ecological worldviews, and personal norms influence pro-environmental behaviour (Alashiq & Aljuhmani, 2025). VBN suggests that individuals act sustainably when they are aware of environmental consequences, feel personally responsible, and perceive a moral obligation to act (Batool et al., 2024). Figure 3 presents VBN and its related constructs.

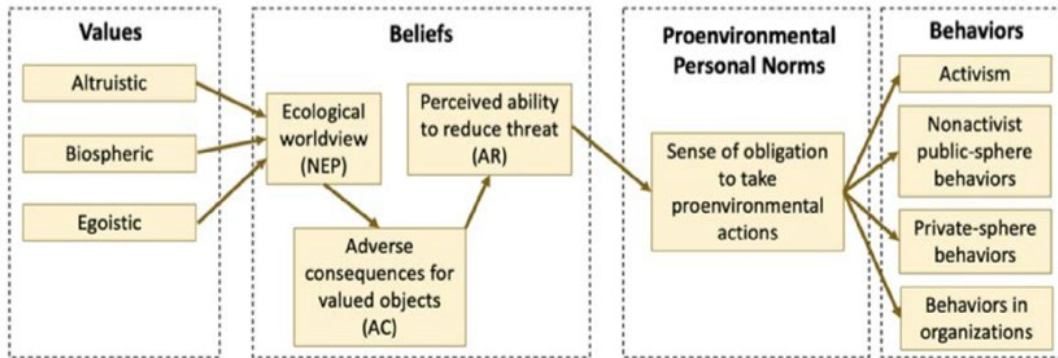


Figure 3: Value-Belief-Norm (VBN) theory

Source: *Batool et al. (2024)*

In the context of fashion, VBN explains why consumers who prioritise ecological and social values may favour sustainable options, such as recycled cotton, even if these are less convenient or more expensive (Alashiq & Aljuhmani, 2025). Arias et al. (2022) found that values strongly predict eco-fashion purchasing. Medapati and Mohan (2025) found that awareness of environmental consequences increases sustainable consumption among young consumers. Al Mamun et al. (2022) established that moral norms influence the adoption of sustainable fashion. In the South African context, where accessibility and cost remain barriers, VBN is particularly useful. It highlights how moral obligations and values can motivate consumers to adopt recycled cotton despite systemic constraints. However, VBN underestimates the weight of economic pressures, meaning that values alone cannot explain behaviour without structural support.

Research Design and Methodology

Research Paradigm and Design

This study was guided by the interpretivist paradigm, which emphasises the process of understanding how individuals construct and negotiate meaning in their social worlds (Du Plooy-Cilliers et al., 2021). Interpretivism rejected the notion of one objective reality; instead, it acknowledged that multiple realities exist, shaped by culture, experience, and context (Alharahsheh & Pius, 2020). The adoption of interpretivism reflected the aim of this study: to understand the ways in which South African fashion students and educators perceived recycled cotton fabric. Unlike positivism, which focuses on measurement and generalisability, interpretivism enables the researcher to engage with lived experiences and uncover the reasons behind empirical behaviour and perceptions.

This study followed an exploratory research design, ensuring that the employed methodologies were consistent with the research objectives (Saunders et al., 2019). Exploratory research design probed subjects that were not sufficiently examined to gain new insights and recognise emerging patterns (Pawar, 2024). This study employed an exploratory research design to address a problem or topic characterised by ambiguity or insufficient comprehension (Saka et al., 2023).



By adopting the exploratory research design, this study unveiled new insights, pinpointed essential themes, and allowed for comprehension of the fundamental reasons behind consumers' attitudes and behaviours. Exploratory research aimed to examine the "what," "why," and "how" of a phenomenon, uncovering new insights, patterns, and potential pathways for further investigation (Aithal et al., 2022).

Research Approach

Aligned with interpretivism, the study employed a qualitative research approach, which emphasised non-numerical data (Flick, 2022). A qualitative approach was particularly valuable for exploring the subtle cultural and social influences shaping consumer perceptions towards sustainability. It allowed flexibility to adapt interviews to participants' responses and to pursue emerging themes (Creswell & Creswell, 2017; Yin, 2022). In this way, the interpretivist paradigm and qualitative approach were utilised to provide a lens that recognised multiple perspectives, valued context, and uncovered the meanings that participants attached to recycled cotton fabric, to add to new knowledge.

Research Method

The next sections provide a detailed overview with justifications of the research methodology of this study.

Population and Sample

Population refers to the entire group of individuals or entities sharing characteristics relevant to a study (Creswell & Creswell, 2017; Creswell & Poth, 2016). Defining this group establishes the boundaries of the research and ensures that findings are grounded in a specific, meaningful context (Casteel & Bridier, 2021). Identifying the appropriate population enhances credibility and clarity (Taherdoost, 2021), while providing a basis for selecting participants who can offer valuable insights (Kumar et al., 2021). For this study, the population comprised South African fashion students and educators familiar with sustainability and recycled cotton fabrics, as they are directly involved in fashion education and practice. This combination enabled a balanced understanding, with students offering contemporary perspectives shaped by their learning, while educators contributed their professional experience, ensuring a diverse and informed range of views (Palinkas, 2020).

Deriving from the identified population, a purposive sample of ten (10) participants was drawn from a South African private higher education institution, consisting of both fashion students and educators, to capture depth and variety in perspectives. Moreover, the sample possesses expertise, hands on experiences and active participation in textile decision making procedures. In addition, this group has greater degree of textile literacy, sustainability awareness and fashion competency since they are crucial stakeholders in the fashion ecosystem. A sample size of ten was deemed appropriate for qualitative research, as data saturation typically occurs between six and twelve participants (Creswell & Creswell, 2017; Creswell & Poth, 2016; Guest et al., 2006).

Research Instrument



This study used an interview guide to collect the required data to address the proposed research questions. The interview guide was demarcated into two main sections. Section A provided the demographic questions, and Section B addressed sub-questions relating to the four secondary research questions indicated earlier in this study.

Data Collection

Data collection is the systematic process of gathering and measuring information to answer research questions (Taherdoost, 2021). In qualitative research, it is to capture participants' perspectives and meanings in their own words, enabling exploration of complex social issues (Creswell & Poth, 2016). This study used primary data through semi-structured interviews with fashion students and educators. Semi-structured interviews were chosen because they balanced consistency with flexibility, allowing key themes such as perceptions of recycled cotton and sustainable fashion to be explored while allowing unexpected insights to emerge through probing (Bearman, 2019).

The interviews were conducted via Microsoft Teams, recorded with consent, and transcribed in verbatim. Each session lasted thirty to forty minutes, striking a balance between depth and participant convenience. Microsoft Teams was selected not only for its security features (DeJonckheere & Vaughn, 2019), but also because it allowed participation from diverse settings, supporting inclusivity in exploring consumer perceptions toward sustainable fashion. This study received ethical approval from STADIO Higher Education (Reference: Stadio-2025-SSOF-MAS082).

Results and Findings

4.1 Role of participants

The demographic data collected during the interviews revealed the participants' roles in fashion, which shaped their responses to recycled cotton. Seven participants were postgraduate students, and three were educators. This suggests that the findings are primarily grounded in the perspectives of students who represent the future fashion workforce, complemented by insights from educators who shape fashion sustainability teaching and practice.

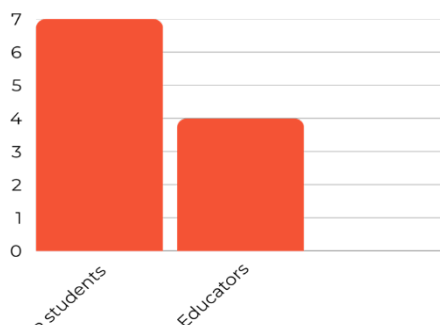


Figure 4: Role of participants

Source: *Authors' Own Work*



Figure 4 shows that postgraduate students formed the majority of the sample of interest, with seven participants, whereas educators accounted for only three participants.

4.2 Years involved in studying or teaching fashion

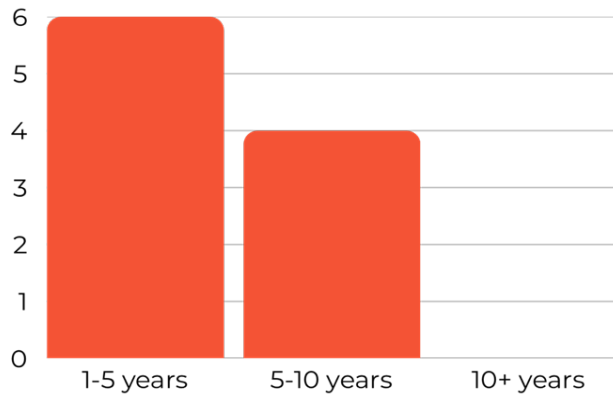


Figure 5: Years involved in fashion

Source: *Authors' Own Work*

Figure 5 illustrates the fashion experience of the participants, thus six participants reported between one and five years of being involved in fashion, while four reported between five and ten years. None had more than ten years of experience.

4.3 Empirical results

In this research, theme analysis was used instinctively rather than mechanically, acknowledging that meaning is co-constructed through interpretation rather than revealed within the data (McLeod, 2024). Naeem et al. (2023) six-steps process was adopted, which included becoming acquainted with the data, developing initial codes, looking for themes, evaluating and refining them, defining and labelling each subject, and ultimately providing a cohesive analytical report.

4.3.1 Generating initial codes

According to Nowell et al. (2017), coding involves assigning labels to meaningful extracts of text to organise raw data into manageable categories. In this study, transcripts were coded line by line, with codes reflecting the issues raised in each research question (RQ).

RQ1: Reduces pollution, avoids landfill, promotes circularity.

Participants consistently associated recycled cotton with environmental protection and waste reduction. P1 stated that: *"the growth of cotton is one of the highest polluters in the fashion industry . . . by not using new cotton, but rather using recycled cotton, I find it more sustainable."* Similarly, P4 explained that: *"upcycling cotton that already exists is a better option,"* while P6 added that: *"you're not wasting like you're upcycling. So it's not going to waste at any point; you're reusing it again and again."* According to Participant 1: *"I find it more sustainable to use recycled*



cotton instead of new cotton because cotton is one of the biggest polluters.” Participant 7 added: *“Recycled cotton promotes circular fashion practices . . . avoids landfills.”* These views highlight a shared understanding that recycling existing cotton supports circularity in fashion and reduces landfill impact, demonstrating strong environmental awareness consistent with SDG 12’s focus on responsible consumption and production.

RQ2: Timeless/durable, reject fast fashion, transparency preference.

Participants perceived recycled cotton apparel as timeless, sustainable, and ethically superior to fast fashion. P3 stated: *“I’m not a big fan of fast fashion...it has a harsh effect on the environment,”* expressing clear ethical resistance to mass production. Likewise, P4 mentioned: *“I would expect upcycled cotton apparel to be more timeless, more sustainable . . . items they can wear for a long time,”* while P10 added: *“I think I prefer the sustainable apparel . . . I do prefer that transparency in my shopping experience.”* Participant 4 described upcycled apparel as *“timeless, sustainable, classic,”* while Participant 3 contrasted it with fast fashion’s destructiveness: *“Fast fashion has a harsh effect on the environment.”* Participant 10 emphasised transparency: *“I think I prefer the sustainable apparel.....I do prefer that transparency in my shopping experience.”* These responses illustrate how participants connect recycled cotton to durability, ethics, and transparency, reflecting a shift toward conscious consumption and a preference for long-lasting, responsibly made cotton fabric clothing.

RQ3: Education changed behaviour, became more conscious, need for awareness.

Knowledge and education were central to shaping participants’ sustainable purchasing behaviours. P2 shared: *“I might actually make better purchasing choices . . . to buy greener and more sustainable fashion,”* showing how awareness influences decision-making. P6 reflected: *“Throughout fashion school, we did learn about sustainability.....it made me think, should I be buying from brands like Shein?”* highlighting the impact of formal education and knowing about SDG 12. Likewise, P10 noted: *“Once you know something and you become conscious of it.....you start to be more aware of the decisions you make.”* These insights demonstrate that sustainability knowledge fosters self-awareness and responsibility, motivating consumers to align their fashion choices with ethical and environmental values in support of SDG 12.

RQ4: Trust, variability and cost implications

Participants identified costs, limited variety, and trust in authenticity as primary barriers to adopting recycled cotton fabric. P3 highlighted that: *“sustainable apparel is more expensive than fast fashion,”* while P7 explained that: *“the high price point doesn’t cater to low or middle-income groups it’s a niche product.”* P9 added that: *“most recycled apparel is uninspiring, poor design appeal and lack of creativity,”* which discourages adoption even among interested consumers. These insights indicate that despite positive attitudes toward sustainability, structural barriers such as cost, trust, and aesthetic limitations hinder practical engagement.

4.4 Discussion of main findings

4.4.1 Environmental textile benefits



Participants frequently emphasised recycled cotton's capacity to lower pollution, landfill usage, and water waste, describing it as an environmentally friendly substitute for virgin cotton. Castellano et al. (2024) stress the importance of recycled textiles in circular economy initiatives that support SDG 12. Similarly, Arafat and Uddin (2022) discovered that fibre recycling considerably decreases greenhouse gas emissions and water consumption, directly contributing to SDG 12 targets, which aim to minimise waste creation via prevention, reduction, and recycling. The current study demonstrates how ethical ideals and sustainability knowledge influence actions that are consistent with SDG12. Ahmad et al. (2023) discovered that knowledge and moral conviction impact eco-friendly purchases among young consumers, highlighting the role of education in creating sustainable consumerism. Gao and Kim (2024) stipulate that moral identity and personal standards influence individuals to make decisions that align with sustainability ideals. Participants' commitment to recycled cotton in this research exemplifies these global goals by demonstrating how educated, ethically aware consumers can support a circular fashion business that puts SDG 12 into effect.

4.4.2 Positive sustainability perceptions

Beyond ecology, participants valued recycled cotton as a symbol of durability, transparency, and authenticity. The participants of this study's views align with Fletcher and Tham (2019)'s findings that sustainable garments can foster "emotional durability" by embedding values in use. More recently, Fletcher and Fitzpatrick (2024) found that durability operates symbolically as well as materially, linking sustainability to cultural meaning and identity. Similarly, Patel et al. (2024) found that consumers often equate recycled textiles with higher quality and reject fast fashion's disposability. Theoretically, the pattern mirrors the social-symbolic dimension of the TPB and VBN: favourable attitudes and socially valued sustainability norms support intentions to choose eco-conscious apparel (Banyt  et al., 2023). While awareness of environmental consequences and a sense of responsibility predict green consumption (Hong et al., 2024). Nevertheless, the symbolism is not universal since some studies report persistent doubts about the quality and performance of recycled textiles (Wagner et al., 2020) and show that pro-sustainability attitudes do not always translate into purchase behaviour (McNeill & Venter, 2019).

4.4.3 Knowledge shapes choices

Knowledge and education emerged as key drivers of sustainable behaviour and fashion choices. Yusliza et al. (2020) maintain that sustainability knowledge directly shapes pro-environmental conduct and aligns with Ahmad et al. (2023), who stress education's role in promoting eco-friendly decisions. However, ENSafrica (2024) observed that many South Africans remain unaware of fashion's environmental impact despite recognising SDG 12, revealing an educational divide between fashion students and the general public. Theoretically, TPB enhances perceived behavioural control through a consumer's knowledge, while in VBN, knowledge activates moral norms that motivate sustainable action. Knowledge also shapes identity: Xu et al. (2022) found that sustainable fashion expresses both ethical and aesthetic values. Yet, as McNeill and Venter, (2019) as well as Joy et al. (2023) argue that awareness alone rarely leads to consistent action, as cost and accessibility often constrain consumers from fully practising their sustainable ideals.

4.4.4 Trust, variability and cost implications



Despite enthusiasm for sustainable fashion, participants identified affordability, limited variety, and mistrust of recycled cotton quality as major barriers. Guria et al. (2024) postulate that there is a prevailing price perception gap, where consumers support sustainability as a principle but resist paying higher prices for it. The United Nations, (2023) reported that such barriers reflect broader economic inequalities. Wang et al. (2023) note that fibre blending techniques used to improve the strength and durability of recycled cotton can compromise its texture and versatility, which often leads to consumer scepticism regarding recycled fabric authenticity and quality.

Theoretically, these barriers reduce perceived behavioural control within the TPB and weaken moral norms within VBN, as cost and quality limitations constrain ethical action. Participants' frustration reveals an awareness-action gap: they value sustainability but face obstacles that hinder its practice. Addressing such challenges requires making sustainable fashion affordable, diverse, and trustworthy.

Managerial Implications

5.1.1 Recommendation based on environmental textile benefits

In South Africa, textile-to-textile recycling remains severely underdeveloped. Although environmental awareness is increasing, Green Cape (2023) notes that the country still lacks the large-scale fibre processing infrastructure needed to support a circular textile economy. Within this context, recycled cotton represents a vital opportunity to move sustainability from aspiration to implementation. It offers a practical route to reduce waste, conserve resources, and redefine fashion as a regenerative rather than disposable system.

Realising this potential, however, requires coordinated managerial action. Starting with integrating recycled cotton into official textile and manufacturing standards, mandating that a measurable portion of apparel production should use recycled fibre. Investment in regional fibre recovery hubs would strengthen industrial capacity and promote local job creation, while a certification scheme jointly endorsed by the Department of Trade, Industry, and Competition and the United Nations Environment Programme would verify authenticity and build consumer confidence. Together, these initiatives would transform recycled cotton from an emerging innovation into a measurable instrument of sustainable production, firmly advancing the aims of SDG 12.

5.1.2 Recommendation based on positive sustainable perceptions

Recycled cotton emerged as more than an eco-friendly material; participants described it as authentic, expressive, and connected to identity. This suggests that sustainability operates not only as an environmental principle but also as a cultural language through which individuals communicate values and belonging. Nevertheless, despite its symbolic power, recycled cotton remains marginal in mainstream branding, often overshadowed by superficial sustainability narratives. To strengthen its cultural visibility, managers of fashion brands and creative institutions could collaborate on initiatives that embed sustainability into everyday consumer experiences.



Interactive exhibitions in shopping districts or museums could allow visitors to see the life cycle of recycled cotton garments, from fibre to fashion, transforming sustainability into a participatory experience. Social media campaigns and short documentary features highlighting local artisans who work with recycled textiles could personalise the narrative and make sustainability feel culturally grounded. Partnering with fashion schools to create limited-edition recycled cotton collections would also show how innovation and sustainability can coexist. Collectively, these initiatives would reposition recycled cotton as a symbol of creativity, authenticity, and national identity, advancing South Africa's broader commitment to SDG 12.

5.1.3 Recommendation based knowledge shaping choice

The results of knowledge shaping choice suggest that while awareness of sustainability exists, it often lacks depth and practical guidance. To transition from awareness to comprehension, knowledge must be institutionalised through systems that reward informed participation by fashion brand managers. With the support of Government agencies, the establishment of a sustainability portal that consolidates verified information about recycled materials, enabling designers, educators, and consumers to access accurate data on fibre origin, processing, and environmental performance would be ideal. This would reduce misinformation and create transparency across the value chain. Similarly, integrating sustainability metrics into retailer product tags, such as water savings, energy use, or waste reduction, would allow consumers to interpret sustainability not as a vague ideal but as a measurable impact.

Industry associations could also develop sustainability competency standards that assess and certify designers, producers, and retailers on their understanding and application of sustainable textile practices. These standards would validate expertise and encourage continuous learning within the industry. By linking sustainability knowledge with professional credibility and career advancement, the fashion sector could move beyond symbolic awareness to measurable accountability and long-term behavioural change.

5.1.4 Recommendation based on trust, variability, and cost implications

High costs, limited variety, and lack of trust remain key barriers to adopting recycled cotton apparel. To enhance affordability, fashion managers could invest in local fibre-to-fibre recycling and small-scale manufacturing to reduce production costs and reliance on imports. Retailers can complement these obstacles by offering adaptive pricing and community-based textile return schemes that make recycled garments more attainable. Rather than relying solely on institutional certification, fashion managers could collaborate with local influencers, artisans, and community leaders who act as ambassadors to achieve transparency by demonstrating the real impact of recycled production.

To overcome issues of cost and variability, cooperative production models could be introduced, whereby smaller design studios share access to recycled materials through collective sourcing agreements. Through collaboration, visibility, and inclusivity, recycled cotton could become a trusted, affordable, and culturally expressive material within South Africa's sustainable fashion landscape.

Conclusions and Future Research



In conclusion, this study provided valuable insights into consumers' perceptions of recycled cotton fabric as discussed by the four main themes that emerged. It is important to acknowledge several limitations. While the small sample of ten participants is suitable for a qualitative approach, it naturally limits the generalisability of the findings. Subsequent research may expand upon this study by incorporating a larger and more heterogeneous participant pool, potentially utilising a mixed-method or quantitative framework, to more comprehensively represent South African consumers. The current sample, made up of only postgraduate students and educators from one private higher education institution, thus limiting perceptions and input from other provinces, educational levels, and occupations, would allow future studies to present a fuller picture of consumer perspectives on the context of this study. Another consideration lies in the relatively short data collection period, which also limited more profound engagement. Extending the research timeline or conducting follow-up interviews could help future researchers explore how perceptions develop over time through a longitudinal study.

Finally, the study's focus on recycled cotton provided conceptual clarity but also narrowed the discussion. Exploring other sustainable fibres, such as hemp, bamboo, or recycled polyester, could offer a richer comparison and connect this research to broader sustainability goals beyond SDG 12. Because this study relied on self-reported perspectives, there is also the possibility of social desirability bias. Future research could address this limitation by combining interviews with behavioural observation or case-based data to compare what people say about sustainability with what they do.



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Generation Z, Leadership Readiness, and the Future of Green Manufacturing: Evidence-based Practices for Sustainable Development

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Abstract

This study examines succession planning and leadership development for Generation Z (Gen Z) within manufacturing and industrial organisational contexts, with particular attention to organisational readiness in the context of green and sustainable development. Adopting a qualitative, interpretivist research design, the thematic analysis was employed to explore how leadership practices and organisational conditions shape Gen Z's preparedness to assume future leadership roles and support leadership continuity. The findings indicate that Gen Z leadership readiness is strongly influenced by leadership styles characterised by participation, coaching, servant, and transformational orientations, while authoritarian approaches were consistently rejected. Leadership practices centred on mentorship, empowerment, and inclusion were identified as critical enablers of succession readiness. Succession planning practices were found to be uneven across organisations and departments. A notable gap was the limited inclusion of Gen Z in succession discussions, increasing organisational vulnerability to leadership discontinuity. Participants articulated clear development priorities for Gen Z, including mentorship and coaching, project ownership, cross-functional exposure, soft skills development, digital leadership capability, and consistent feedback and recognition. Without these supports, Gen Z leaders risk remaining technically competent but strategically underprepared. Organisational readiness was mixed, with leadership mindset readiness emerging as a critical determinant; resistance to change among senior leaders significantly constrained effective succession planning. The study concludes that strengthening Gen Z leadership readiness requires more than technical training or operational continuity. Effective succession planning depends on adaptive leadership styles, inclusive organisational cultures, formalised succession frameworks, targeted developmental investments, and organisational readiness aligned with long-term sustainability and green manufacturing objectives.

Keywords: Generation Z leadership, Succession planning, Organisational culture, Leadership development, Organisational readiness, Sustainable manufacturing



Introduction

Background

Corporate agility, relevance, and organisational resilience are contingent upon a firm's ability to align internal capabilities such as workforce competence, organisational culture, and leadership with external forces including market dynamics, technological change, and global economic cycles (Jha et al., 2024; Lee & Werner, 2023). In manufacturing organisations pursuing green and sustainable development, these demands are intensified, as firms must continuously adapt while preserving accumulated institutional knowledge derived from past successes and failures (Koporcic et al., 2025). Such institutional learning provides the foundation upon which sustainable strategies are formulated and refined.

At the core of this adaptive capacity lies leadership. Leadership not only influences strategic decision-making but also shapes organisational culture, norms, and values that underpin long-term performance and adaptability (Showry & Manasa, 2014). Prior studies underscore the centrality of leadership in sustaining organisational relevance within increasingly competitive and volatile environments (Garustowicz & Dawidowicz, 2025; González-Moreno et al., 2024; Kampilong et al., 2025; Kant et al., 2025; Langer & Acciaro, 2025; Rodrigo et al., 2025). Empirical and historical evidence further illustrates that leadership effectiveness can determine organisational trajectories (Kampilong et al., 2025) with situational conversation of citing Nokia's decline linkage to leadership's failure to nurture innovation, that of Amazon's sustained growth aligns to visionary and adaptive leadership practices (Gokul & Monisha, 2023; Kazemi et al., 2024).

Problem Statement

Despite its importance, leadership is inherently transient rather than permanent (Stone, 2023). Leadership transitions are therefore inevitable, rendering succession planning a strategic imperative for maintaining organisational continuity, safeguarding institutional knowledge, and preserving strategic direction (Ahmad et al., 2023; Rothwell, 2016). Empirical research further indicates that ineffective succession planning contributes to leadership vacuums, strategic discontinuity, and loss of firm-specific knowledge, particularly in technically specialised sectors such as manufacturing (Collings & Mellahi, 2009; Day, 2011). However, effective succession planning extends beyond identifying high-performing individuals; it requires alignment between leadership competencies, cultural fit, and organisational performance expectations (Martin & O'Shea, 2021). Lissitsa & Laor, (2021) and Balon, (2024) made it known that since people actively construct and reproduce organisational culture, understanding the attributes that facilitate leadership effectiveness and cultural compatibility is critical for sustainable organisational development.

In response, organisations increasingly recognise the necessity of systematically upskilling employees and preparing internal talent pipelines for future leadership roles, particularly as industries undergo structural, technological, and sustainability-driven transformation (Nguyen et al., 2023; World Economic Forum, 2023). The manufacturing sector, in particular, faces intensifying pressures associated with digitalisation, decarbonisation, and the transition toward greener production models, all of which require new leadership capabilities and adaptive mindsets (Kagermann et al., 2013; Sony & Naik, 2020). This challenge is especially pronounced in manufacturing firms transitioning toward greener and more sustainable models. Madzik et al.



(2026) was of the position that as Baby Boomers and Generation X progressively exit the workforce and Millennials assume leadership positions, a critical gap remains in understanding how Generation Z can be effectively developed and aligned with the cultural, strategic, and sustainability imperatives of contemporary manufacturing organisations. Although Generation Z exhibits strong potential, particularly in digital literacy, innovation orientation, and sustainability consciousness, their readiness to assume leadership roles within manufacturing contexts remains underexplored (Schroth, 2019; Seemiller & Grace, 2019). This gap is especially salient in environments requiring organisational resilience, innovation, and cross-generational collaboration. Consequently, limited scholarly attention has been given to identifying structured practices and interventions capable of strengthening Generation Z's leadership readiness in manufacturing firms.

Accordingly, this study addresses the central research question: *What practices or interventions can strengthen Generation Z's readiness for leadership in manufacturing firms?* By focusing on leadership development, organisational culture, and succession planning, this study contributes to the literature by advancing an evidence-based understanding of how Generation Z can be prepared to lead green and sustainable manufacturing organisations in the future.

To achieve this aim, the study pursues the following specific research objectives:

1. To analyse how organisational culture influences Generation Z's leadership readiness and integration into manufacturing leadership pipelines.
2. To identify targeted practices and interventions that can strengthen Generation Z's preparedness for future leadership in sustainable manufacturing organisations.

1.4 Research Justification

This research is justified by two pressing, interrelated concerns; The imminent retirement of Baby Boomer and Gen X leaders with an intent to a critical succession vacuum in manufacturing, necessitating a proven framework for developing the next generation and the retention and engagement of Generation Z. the second view posits the future leadership cohort in requiring organisational and leadership adaptations being aligned with their values around sustainability, ethics, and development. An evidence-based understanding of how to achieve this is vital for the long-term competitiveness of firms, especially those committed to green manufacturing principles.

Literature Review

Generational Dynamics and Leadership Pipeline Sustainability

The long-term viability of manufacturing organisations is contingent upon robust leadership pipelines capable of navigating generational succession. Grounded in generational theory, which posits that cohorts shaped by shared socio-economic and technological milieus develop distinct work values and behaviours (Balon, 2024; Sakdiyakorn et al., 2021), via the imperative alignment of succession planning with generational shifts. This alignment is critically underexplored within manufacturing sectors undergoing concurrent digital and green transitions, presenting a key research gap. Scholarly consensus has been able to identify Generation Z as bringing a distinct profile to the workplace: digitally native, change-resilient, and ambitious, yet also characterized by a need for validation and sensitivity to rigid hierarchies (Dimokas, 2025; Hutanu et al., 2020;



Madden, 2024). Their leadership preferences lean decisively towards participatory, coaching-based styles, with high value placed on autonomy, continuous learning, and purposeful work (Pantelides, 2024; Răcolta-Paina & Irini, 2021). This presents a fundamental challenge to traditional, hierarchical manufacturing cultures.

Critically, their strong orientation towards ethical conduct, social responsibility, and environmental sustainability (Sakdiyakorn et al., 2021) makes corporate reputation and authentic ethical leadership direct factors in their engagement and retention. However, their lower organisational loyalty, preference for non-linear careers, and high expectations for rapid feedback and progression (Decarvalho, 2025; Hidayat, 2024) complicate traditional linear succession models. Organisational responses, such as flexible work arrangements and transparent pathways (Kulkarni & Rai, 2023), have had limited success, indicating a deeper misalignment between systemic leadership development practices and Gen Z motivations, particularly in emerging economy contexts like South Africa where economic pressures further amplify entrepreneurial and portfolio-career tendencies.

Leadership Styles and Succession Planning Systems

Succession planning is a strategic linchpin for organisational sustainability (Saleem, 2023; Yarangga, 2023). Of a truth, literature has robustly established that leadership style is not peripheral but central to its efficacy, serving as a key mechanism for developing leadership readiness (Jones, 2024; Siambi, 2022). Transformational leadership, with its emphasis on vision, inspiration, and individualised consideration, is strongly correlated with positive succession outcomes and enhanced subordinate readiness (Ahmad et al., 2017). However, scholarship cautions against a purely charismatic reliance, underscoring the necessity of institutionalised systems and supportive structures (Kampilong et al., 2025). Contrarily, Figueiredo (2022) introduces a critical nuance, suggesting that under specific conditions, *laissez-faire* leadership may foster self-directed development, while practices like coaching and 360-degree feedback systematically strengthen internal pipelines. Emerging paradigms in the likes of adaptive leadership (Heifetz et al., 2009), distributed leadership, and servant leadership are theoretically congruent with Generation Z's preferences and the collaborative, agile demands of modern manufacturing (Dreyer & Stojanová, 2023). Yet, a significant fragmentation persists in the literature. There is a pronounced lack of empirical integration examining *how* these leadership styles interact with Generation Z's specific traits within the operational and cultural confines of the manufacturing sector, revealing a critical contextual gap.

The Foundational Role of Ethical Culture, Reputation and Manufacturing Intergenerational Dynamics

Organisational culture sets the parameters for ethical behaviour, which in turn is a cornerstone of corporate reputation (Smith & Drudy, 2022). An ethical culture, reinforced by leadership modelling and reward systems (Oriade et al., 2021), enhances employee morale, supports CSR initiatives, and mitigates reputational risk (Burrell et al., 2024; Kim & Lee, 2024). For Generation Z, for whom organisational ethics and sustainability are salient employment criteria, this culture is not merely supportive but essential. Thus, ethical leadership transitions from a moral imperative to a strategic



enabler of succession planning, directly influencing the attractiveness of leadership roles to this cohort (Cisneros et al., 2022; Coffie et al., 2025).

The manufacturing workforce is a multigenerational ecosystem. Baby Boomers offer deep institutional knowledge but may resist digital shifts, while Generation X often acts as a pragmatic bridge (Lissitsa & Laor, 2021). Millennials drive digitalisation but seek flexibility (Rehman et al., 2024). Generation Z, as the first fully digital native cohort, is uniquely poised to lead Industry 4.0 and sustainability initiatives (Shabib et al., 2021). The core challenge for succession planning lies in designing development systems that leverage the strengths of each cohort, particularly the knowledge of older generations and the digital acuity of Gen Z while navigating Gen Z's distinct career patterns and expectations.

Literatures converges on several key points but exposes a definitive empirical lacuna. While generational traits (especially of Gen Z) and effective leadership styles are well-documented in isolation, and the importance of ethical culture is established, their *interdependent* relationship in shaping leadership readiness remains poorly understood (Aksar et al., 2025; Dreyer & Stojanová, 2023, 2023; Self et al., 2019). Specifically, there is scant research investigating how leadership development practices and organisational culture (with its ethical dimension) collectively influence the leadership readiness of Generation Z within the specific context of green manufacturing. Therefore, this study is methodologically designed to address this integrated gap. This is done by empirically examining the relationships between these constructs, treating leadership styles and organisational/ethical culture as independent or mediating variables, and Generation Z's leadership readiness as the dependent outcome. The methodology flows directly from the need to test the theoretical linkages suggested, but not confirmed, by the extant literature.

Conceptual Synthesis and Research Gap

The literature converges on several key points but exposes a definitive empirical lacuna. While generational traits (especially of Gen Z) and effective leadership styles are well documented in isolation, and the importance of ethical culture is established, their interdependent relationship in shaping leadership readiness remains poorly understood (Aksar et al., 2025; Dreyer & Stojanová, 2023; Self et al., 2019).

Conceptually, the literature suggests a multilevel leadership readiness model:

- Leadership development practices and leadership styles → shape capability formation (development pathway)
- Organisational/ethical culture → conditions motivation, identification, and succession legitimacy (contextual pathway)
- Generational attributes (Gen Z traits) → influence learning preferences and leadership orientation (individual pathway)

However, there is scant research investigating how these factors collectively influence Generation Z leadership readiness within green manufacturing contexts. Therefore, this study is methodologically designed to address this integrated gap by empirically examining the relationships between these constructs, treating leadership styles and organisational/ethical culture as independent or mediating variables, and Generation Z's leadership readiness as the dependent outcome. The methodology flows directly from the need to test the theoretical linkages suggested but not empirically confirmed by the extant literature.



Research Design and Methodology

The study employed a qualitative research design, which is further discussed below in different sections for clarity.

Research Approach and Design

This study adopts a qualitative research design to explore how leadership styles and organisational culture shape Generation Z's readiness for succession planning within manufacturing environments. The choice of a qualitative approach is informed by the study's objective to develop a context-sensitive and meaning-oriented understanding of leadership development processes rather than to test predefined causal relationships. Given that leadership readiness, cultural alignment, and succession aspirations are socially constructed and experienced differently across organisational contexts, a qualitative design allows for deeper engagement with participants' lived experiences and interpretations. The study is grounded in an interpretivist research paradigm, which assumes that organisational realities are co-created through social interaction, values, and shared meanings (Kweekel et al., 2026; Pramila-Savukoski et al., 2023). This paradigm is particularly appropriate for examining how Generation Z employees, human resource professionals, and organisational leaders perceive leadership, culture, and future leadership pathways within manufacturing firms. By privileging participants' voices, the study seeks to uncover how leadership styles and organisational cultures are experienced, interpreted, and negotiated in practice, especially in relation to leadership succession. Rather than pursuing breadth, the study prioritises analytical depth, enabling the identification of nuanced patterns and contextual variations that may not be captured through quantitative approaches. This design supports the broader aim of generating rich insights capable of informing leadership development and succession strategies tailored to Generation Z within manufacturing organisations.

Data Analysis Method

Data was analysed using thematic analysis, a flexible and rigorous qualitative technique for identifying, analysing, and interpreting patterns of meaning within textual data. The analysis follows an iterative and reflexive process comprising several stages (Kweekel et al., 2026; Shokri et al., 2025):

1. Familiarisation with the data through repeated reading of interview transcripts
2. Initial coding to identify meaningful units related to leadership, culture, and succession planning
3. Development of broader themes through the clustering of related codes
4. Review and refinement of themes to ensure coherence and analytical relevance
5. Definition and naming of themes to capture their conceptual essence
6. Interpretation and synthesis of findings in relation to the research questions and existing literature

Qualitative data analysis software was used to support the organisation, coding, and retrieval of data. This was the ATLAS Ti and it brought about the analytical approach which enabled the identification of leadership styles and cultural elements that influence Generation Z's leadership readiness while also capturing contextual differences across manufacturing settings.



Sampling Strategy and Sample Size

Purposive sampling was used to identify participants who meet the study's inclusion criteria, with snowball sampling employed where appropriate to access additional key informants. This approach enhances access to participants with specialised knowledge while maintaining relevance to the research focus. The captured sample size were 15 participants, with data collection from the link tracing method of the linked in app until theoretical saturation was achieved. Saturation was reached when additional interviews no longer yield new themes or insights, indicating sufficient depth and coverage of the research phenomena.

Data Collection

Data are collected through semi-structured interviews, which provide both structure and flexibility in exploring participants' perspectives. This method is well suited to the study's exploratory focus, as it allows participants to articulate their experiences and views in their own words while ensuring consistency with the research objectives. An interview guide was developed to facilitate discussion around key themes emerging from the literature review, including leadership styles, organisational culture, and succession planning. The guiding questions focus on; Participants' perceptions of effective leadership and preferred leadership behaviours; Experiences of organisational culture and its influence on professional development; Views on succession planning practices and leadership opportunities within manufacturing firms; Generation Z's interest in, and readiness for, leadership roles and finally Perceived barriers and enablers to developing future leaders from within the Generation Z cohort.

The semi-structured format allows the researchers to probe emergent issues, clarify meanings, and explore unanticipated insights, thereby enhancing the depth and richness of the data. A purposive sampling strategy was employed to ensure participation by individuals with direct experience and insight into leadership development and succession planning within manufacturing organisations. Two participant groups were targeted to capture multiple perspectives on leadership readiness:

- Generation Z employees (aged 18–31) currently employed in manufacturing organisations, who can reflect on their leadership aspirations, developmental experiences, and cultural fit
- Human resource professionals and managers, particularly those involved in talent management, leadership development, and succession planning, who can provide organisational and strategic perspectives

It must be noted that the included participants across different organisational roles and sizes allowed the study to examine how leadership and cultural dynamics operate at both individual and organisational levels, contributing to a more holistic understanding of succession planning practices.

Ethical Considerations

Ethical integrity is central to the conduct of this study, particularly given the personal and potentially sensitive nature of workplace experiences. Several measures are implemented to ensure ethical compliance. Informed consent was obtained from all participants after providing clear information about the study's purpose, procedures, and rights. Furthermore, Confidentiality and anonymity was ensured through the use of pseudonyms and the removal of identifying information from transcripts and reports. Also, voluntary participation and the right to withdraw are upheld throughout the research process, with participants free to exit the study at any point without



consequence. In some cases, debriefing was offered following interviews to address questions or concerns. It was on this note that the ethical approval for the study was granted by the relevant institutional ethics review board. In addition, the study complies fully with the Protection of Personal Information Act (POPIA), ensuring that all personal data are securely stored, confidentially handled, and used solely for academic purposes.

Results and Findings

The study sample consisted of participants from a diverse mix of generational cohorts, with the majority being Millennials, alongside several participants from Gen Z and Gen X (Figure 1).

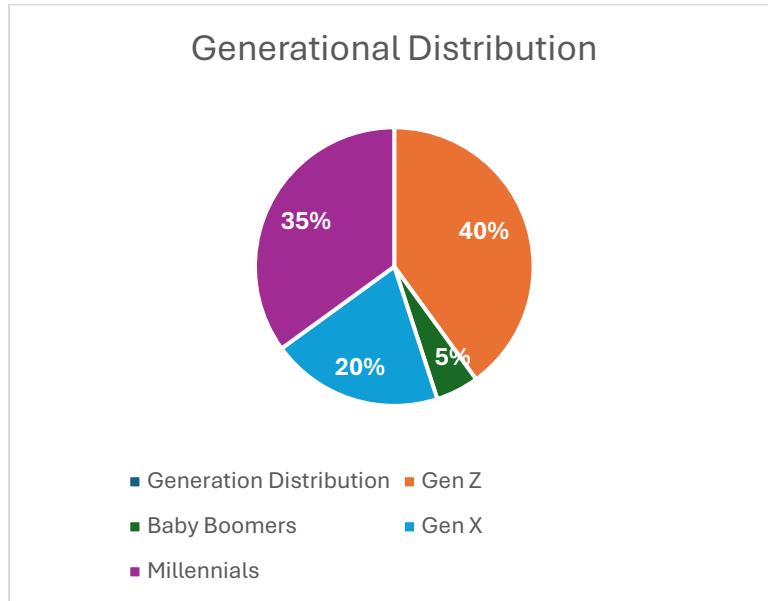


Figure 1. Generational Distribution of the participants

Their industry experience ranged from 1 to 19 years (Figure 2), spanning the diverse manufacturing organisation types.

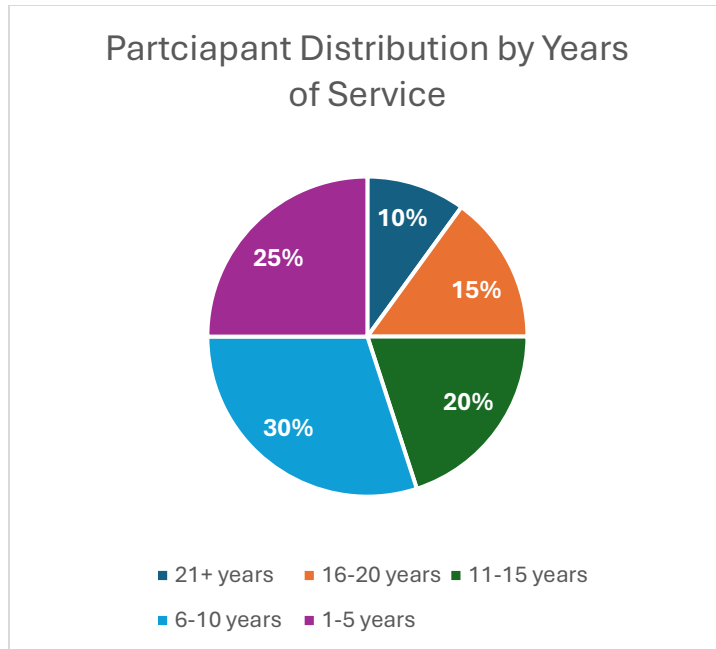


Figure 2. Participation Distribution by Years of Service

This study examines the critical factors shaping succession planning within manufacturing and industrial contexts, with particular emphasis on the leadership development and readiness of Generation Z employees. The analysis foregrounds how leadership styles and organisational culture influence the extent to which Gen Z is prepared and supported to assume future leadership roles. Drawing on the study's empirical findings, key recommendations are identified to strengthen succession planning practices and enhance leadership pathways for Generation Z. The results are organised around core themes and related subthemes that capture Generation Z's development needs. Each theme is discussed below, accompanied by supporting quotations from participants. The research question, ranging from leadership attributes and development to Gen Z readiness and cultural alignment, was connected to subtheme nodes, including adaptability, communication and succession planning. These nodes represent the subtlety dimensions of leadership and organizational culture that influence the development and inclusion of Gen Z in succession planning.

Table 1 Theme ranking according to recurrence level

Rank	Theme	Recurrence level	Description
1	Gen Z Development Needs	High	Mentorship, project ownership, soft skills, and digital fluency were repeatedly identified as essential for Gen Z leadership readiness.
2	Organisational Readiness	Moderate	Mixed views were shared; some organisations were moderately prepared, others structurally unprepared. Readiness was often tied to leadership mindset.



4.1 Theme 1 Gen Z development needs

This theme explores the specific developmental needs identified by participants as essential for preparing Gen Z employees for future leadership roles. Respondents consistently emphasised that younger employees require structured support, opportunities for growth, and recognition to thrive in succession pipelines. The subthemes highlight mentorship and coaching, project ownership and cross-functional exposure, soft skills training, digital leadership training, and feedback and recognition. These represent the development priorities that organizations embed into their leadership frameworks to ensure a smooth generational transition and sustainable succession planning.

4.1.1 Subtheme: Mentorship and coaching

Participants highlighted mentorship and coaching as critical enablers of Gen Z development. Respondents emphasised that younger employees value guidance, constructive feedback, and opportunities to learn directly from experienced leaders. Mentorship was decried as a means of transferring tacit knowledge, while coaching was seen as essential for building confidence and leadership readiness. One participant stated,

“Mentorship and coaching are critical for preparing Gen Z for leadership roles” (Participant 10).

In contrast, others noted that

“leaders must guide and support rather than just manage tasks” (participant 16).

With these comments, it was perceived that several issues were raised regarding the lack of structured mentorship programs, with some participants feeling excluded from development opportunities. The findings are in alignment with studies showing that mentorship and coaching enhance engagement, retention, and succession readiness by fostering continuous learning and empowerment (Toni et al., 2025; Susanto and Sawitri, 2022).

4.1.2 Subtheme: Project ownership and cross-functional exposure

Respondents emphasised the importance of project ownership and cross-functional exposure in developing Gen Z employees. Participants noted that being entrusted with responsibilities builds confidence and prepares younger staff for leadership roles, while exposure to different functions broadens their understanding of organisation dynamics. One of the respondents stated,

“We want opportunities to take ownership of projects and pave the way for ourselves” (participant 15).

In contrast, another participant stated,

“Cross-functional exposure helps us to understand the bigger picture” (participant 9).

Issues that the participants raised include limited opportunities for Gen Z to lead projects or participate in cross-functional exposure, which restricts their development.

4.1.3 Subtheme: Soft skill training

Participants consistently identified soft skills training as a developmental priority for Gen Z. Respondents highlighted that while technical competence is important, younger employees require training in communication, emotional intelligence, adaptability, and teamwork to succeed in leadership roles.



“Collaboration and teamwork, effective communication, emotional intelligence, adaptability” are essential for leadership effectiveness (participants 8).

However, the lack of structured soft skills training in organisations is one issue raised by participants, as organisations often focus narrowly on technical development.

4.1.4 Subtheme: Digital leadership training

Digital leadership training was highlighted as a key developmental need, reflecting Gen Z's expectation of technologically enabled workplaces. Participants noted that younger employees value leaders who are digitally competent and able to leverage technology for innovation and collaboration. This is highlighted by one respondent, who stated that

“Digital skills are essential for future leaders, especially for Gen Z” (Participant 13).

Similar to the previous subtheme, the lack of structured digital leadership programs was a significant issue, as organizations struggled to prepare employees for technology-driven leadership. Literature confirms that digital leadership training is essential for succession planning, as it equips younger employees with the skills to lead in dynamic, technology-intensive environments (Zeng *et al.*, 2025).

4.1.5 Subtheme: Feedback and recognition

Ultimately, participants emphasized the importance of feedback and recognition for the development of Gen Z. Respondents highlighted those younger employees value regular, constructive feedback and recognition for their contribution, which fosters motivation and engagement. One participant explained that

“we want leaders who are involved in decisions, not just tell us what to do” (participant 15),

while another stated that

“participative leadership makes us feel valued and part of the bigger picture” (participant 19)

However, the participants also raised concerns in that inconsistent feedback practices and limited recognitions were seen as demotivating. According to Jones (2024), feedback and recognition are critical to engagement, retention, and succession readiness, particularly among the younger generations.

4.2. Theme 2 Organisational readiness

This theme explores the extent to which organisations are prepared to integrate Gen Z into leadership pipelines and succession planning frameworks. Participants revealed varying levels of readiness, ranging from moderately prepared organizations with partial structures in place to those that were structurally unprepared for generational transitions. The theme also highlights the importance of leadership mindsets, readiness, and identifies strategic foresight gaps that hinder long-term succession planning. Collectively, these sub-themes show that organisational readiness is uneven, with significant implications for the sustainability of leadership development and generational transitions.

4.2.1 Subtheme: Moderately prepared organisations

Participants highlighted that some organisations are moderately prepared for succession planning, with partial frameworks and development initiatives in place. Respondents noted that



while these organizations have begun to integrate mentorship, training, and leadership pipelines, their efforts remain inconsistent and lack complete alignment with the expectations of Gen Z. This is highlighted by one of the respondents stating that

“structured succession planning ensures continuity and prepares younger employees for leadership responsibilities” (Participant 7).

However, other respondents observed that communication and implementation are uneven. Again, issues related to the limited visibility of succession frameworks and inconsistent application across departments were flagged. According to Altamimi et al. (2023), moderately prepared organizations often have the right structures but fail to consistently embed them, which reduces their effectiveness.

4.2.2 Subtheme: Structurally unprepared organisations

Other participants described organizations as structurally unprepared for succession planning, with little to no frameworks in place. Respondents emphasized that leadership transitions are often handled informally or reactively, leaving younger employees excluded from opportunities for development. This is highlighted by one of the participants (**Participant 12**), who states,

“Succession planning is often reactive and based on who is available rather than who is prepared.”

The issues raised were that there is a firm reliance on ad-hoc practices, a lack of formal leadership pipelines, and a weak integration of Gen Z into succession discussions. This is concerning, as structurally unprepared organizations tend to undermine leadership development and create instability, often leaving succession planning to chance rather than adopting a strategic approach (Williams, 2021; Mphaluwa et al., 2025).

4.2.3 Subtheme: Leadership mindset readiness

Participants emphasised that organisational readiness is not only structural but also dependent on leadership mindset. Respondents highlighted that leaders who embrace inclusivity, mentorship, and adaptability are better positioned to prepare Gen Z for leadership roles. This is pointed out by one **participant, 7**, who states,

“Leaders must be flexible and solution-oriented, not rigid in their approach.”

Resistance to change among senior leaders, with some preferring the traditional hierarchical model that aligns with younger employees, was flagged as one of the main fundamental issues. Leadership mindset readiness is crucial for effective succession planning, as leaders must transition from a command-and-control approach to coaching and participative styles to effectively engage Gen Z (Corrington, 2025; Sharma, 2023).

4.2.4 Subtheme: Strategic foresight gaps

Finally, participants identified strategic foresight gaps as a significant weakness in organisational readiness. Respondents noted that many organisations fail to anticipate future leadership needs or align succession planning with long-term strategy. This is pointed out by **participant 18**,

“Gen Z employees are not yet fully included in leadership discussions,” highlighting the lack of forward-looking planning.

The respondents raised concerns regarding reservations in short-term focus, reliance on external recruitment, and limited investment in leadership development for young people. As alluded to by



Siambi (2022), strategic foresight is essential for succession planning, as organisations must anticipate generational transitions and embed long-term leadership development into their strategy.

Theme 1: Gen Z development Needs	1.1 Mentorship and coaching	Structured guidance from experienced leaders to build confidence and leadership capacity.
	1.2 Project ownership and cross-functional exposure	Opportunities to lead initiatives and rotate across departments to broaden strategic insight.
	1.3 Soft skills training	Development of communication, conflict resolution, and stakeholder management capabilities.
	1.4 Digital leadership programs	Integration of technology, innovation projects, and reverse mentorship to harness Gen Z's digital fluency.
	1.5 Feedback and recognition	Regular, constructive feedback to reinforce growth, motivation, and performance
Theme 2: Organisational Readiness	2.1 Moderately prepared organisations	Offer mentorship and training but lack full leadership transition mechanisms.
	2.2 Structurally unprepared organisations	Retain rigid hierarchies and outdated systems that hinder the advancement of Gen Z.
	2.3 Leadership mindset readiness	The degree to which senior leaders embrace generational transition and inclusive leadership.
	2.4 Strategic foresight gaps	Absence of long-term planning for leadership continuity and generational integration.

Organisational Readiness is the least ranked amongst them, implying that many organizations may not yet be structurally or strategically prepared for generational transition. This gap has implications for risk management as organisations may face unplanned leadership discontinuity if readiness is not addressed through strategic planning. In the subthemes, the most frequent subthemes are Mentorship and coaching (7), communication skills (8), transformational and coaching leadership (6), and inclusive culture (6). Moreover, the least frequent subthemes Are Operational efficiency, servant leadership, structured cultures, and strategic foresight gaps (3). This suggests that soft skills, such as mentorship and inclusive leadership styles, are the primary drivers of Gen Z readiness. In contrast, traditional emphases on efficiency, rigid structures, and servant leadership alone are insufficient. Therefore, organisations must invest in succession planning that encompasses communication, coaching, inclusivity, and transformational



leadership, while also addressing overlooked areas such as strategic foresight, to ensure a sustainable generational transition

Managerial Implications

The findings carry significant implications for manufacturing leaders, human resource professionals, and policymakers concerned with leadership continuity and sustainability. From a managerial perspective, the study suggests that organisations must move beyond ad-hoc or reactive succession planning toward intentional, development-centred leadership pipelines. Mentorship and coaching should be formalised rather than left to individual discretion, and project ownership should be systematically embedded into development pathways for younger employees. Importantly, leadership development must extend beyond technical competence to include soft skills, emotional intelligence, and participative leadership capabilities. This resonates with studies such as Hauck & Prügl, (2015) and Khuadthong et al., (2025) who view the need for such necessity abilities for the new generational ability transfer.

For senior leaders, the findings underscore the importance of **leadership mindset** transformation. Traditional command-and-control approaches prevalent in manufacturing are increasingly misaligned with the expectations and developmental needs of Generation Z. Leaders who adopt inclusive, coaching-oriented, and adaptive styles are better positioned to cultivate leadership readiness and retain emerging talent.

At a policy and strategic level, the study highlights the need for organisations pursuing green manufacturing to integrate succession planning into sustainability strategy. Thus aligning the views of Pantaruk et al., (2025) on the stance that Leadership continuity is not only a human capital concern but also a risk management issue, particularly in contexts marked by technological disruption, environmental regulation, and demographic change.

Theoretical Contributions

This study makes several important contributions to the leadership, generational, and sustainability literatures. First, it advances succession planning theory by conceptualising leadership readiness as a relational and systemic phenomenon, rather than an individual attribute (Carter et al., 2019; Deitte et al., 2021). In doing so, it extends existing models that focus narrowly on leadership competencies by incorporating organisational readiness and cultural alignment as necessary enabling conditions.

Second, the study contributes to the growing body of generational leadership research by empirically demonstrating how Generation Z's leadership readiness is contingent on specific organisational practices, rather than on assumed generational deficiencies or preferences. While prior studies (Aksar et al., 2025; Dreyer & Stojanová, 2023; Garustowicz & Dawidowicz, 2025; Madzik et al., 2026) have documented Gen Z's values and work orientations, this research integrates these insights with leadership development and succession planning processes within manufacturing contexts.

Third, the study extends sustainability and green manufacturing scholarship by positioning leadership succession as a strategic enabler of sustainable development. By linking leadership readiness to ethical culture, digital capability, and long-term strategic foresight, the findings highlight leadership succession as a critical mechanism through which green manufacturing ambitions can be institutionalised and sustained over time.



Implications for Sustainable and Green Manufacturing

The study was able to ensure that there is a transition toward green and sustainable manufacturing intensity on the importance of leadership succession. The research was able to establish that sustainable production systems require leaders who are capable of managing technological innovation, ethical responsibility, and long-term stakeholder value. The findings indicate that Generation Z possesses the digital fluency and sustainability orientation required for this transition, but organisational systems often lag behind in enabling their leadership development. In the lieu of using the harnessed data to demonstrate that leadership readiness is shaped by organisational culture, mentorship structures, and strategic foresight, this study positions Generation Z not merely as a future workforce but as a strategic leadership asset for sustainable manufacturing. Organisations that fail to invest in readiness risk not only leadership discontinuity but also stagnation in sustainability innovation

Conclusions and Future Research

This study set out to address a critical but underexplored question of what practices or interventions can strengthen Generation Z's readiness for leadership in manufacturing firms, particularly within the context of green and sustainable development? Drawing on qualitative evidence from manufacturing professionals across generational cohorts, the findings demonstrate that Generation Z's leadership readiness is neither automatic nor generationally predetermined. Instead, it emerges as a co-produced outcome, shaped by the interaction between individual developmental opportunities and organisational readiness for generational transition. The results reveal two interdependent pillars of leadership readiness. First, Generation Z development needs and had the sub themes of mentorship and coaching, project ownership, cross-functional exposure, soft skills development, digital leadership capability, and continuous feedback form the foundational conditions through which leadership potential is translated into readiness. Second, organisational readiness and had the sub themes of encompassing structural preparedness, leadership mindset, and strategic foresight, determines whether these developmental investments are sustained, legitimised, and integrated into formal succession planning systems. Crucially, the study shows that even highly motivated and capable Gen Z employees are unlikely to progress into leadership roles in the absence of organisational systems that are inclusive, forward-looking, and aligned with sustainability objectives. Conversely, organisations that invest in leadership development without addressing leadership mindset rigidity or strategic short-termism risk undermining their own succession pipelines.

While the study provides rich and contextually grounded insights, several limitations should be acknowledged. First, the qualitative design prioritises depth over breadth, which limits statistical generalisability. However, the findings offer strong analytical transferability to similar manufacturing and industrial contexts.

Second, the reliance on self-reported perceptions introduces the possibility of social desirability bias, particularly in discussions of leadership and organisational culture. Although confidentiality and reflexivity were employed to mitigate this risk, future studies may benefit from triangulating interview data with organisational documents or observational methods.

Finally, the study focuses primarily on manufacturing contexts within a specific institutional and economic environment. Leadership readiness and succession dynamics may differ across regions or sectors, particularly in highly regulated or capital-intensive industries.



Directions for Future Research

Future research can build on this study in several ways. Quantitative or mixed-methods studies could test the relationships identified here, examining the mediating role of organisational readiness between leadership development practices and leadership outcomes. Longitudinal research would be particularly valuable in tracking how Generation Z employees transition into leadership roles over time. Further studies could also explore cross-cultural or cross-sectoral comparisons, investigating whether the patterns observed in manufacturing hold in other sustainability-oriented industries. Finally, future research could examine the role of digital transformation and artificial intelligence in reshaping leadership readiness and succession planning for emerging generations.

In conclusion, this study demonstrates that strengthening Generation Z's readiness for leadership in manufacturing firms requires more than individual capability development. Leadership readiness is co-created through intentional developmental practices and inclusive leadership mindsets aligned with long-term sustainability goals. As manufacturing firms confront demographic shifts and the imperative of green transformation, investing in Generation Z leadership readiness is not optional but rather strategic. By embedding leadership development within succession planning and sustainability agendas, organisations can secure not only leadership continuity but also the future of green manufacturing itself.



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A literature review of an MBA organisational behaviour and change module's contributions to responsible management and SDG embedding

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Abstract

Organisations face increasing pressure to align their strategies and operations with the Sustainable Development Goals. Many firms publish SDG commitments, yet weak integration persists within their routines and decision-making systems. This article analyses how an MBA module in Organisational Behaviour and Change supports responsible management and the embedding of the SDGs. A focused literature review maps behavioural drivers across regulatory, governance, and individual levels, plus change mechanisms across strategy, measurement, partnerships, capability, and resourcing. The synthesis shows three conditions for durable integration. External pressure must align with internal values. Governance must convert SDG intent into oversight, targets, and assurance. Capability must equip leaders and teams to manage trade-offs and redesign work systems. This paper positions MBAD 828, Organisational Behaviour and Change, as a capability-building module in an MBA program that trains students to move from SDG intent to SDG execution. It does so through an applied assessment pathway that requires a literature review that links responsible management to change levers in governance, leadership, and human resource systems.

Keywords: ethical leadership, governance, green human resource management, MBA curriculum, organisational change, sustainable development goals

Introduction

1.1 Background

Organisations operate under increasing pressure to demonstrate responsible conduct and measurable contributions to sustainable development. The 17 Sustainable Development Goals (SDGs) offer a shared framework for addressing poverty, inequality, and climate risk through coordinated action across sectors and countries (United Nations, 2015). Many organisations now reference the SDGs in strategy documents and sustainability reports. This visibility has value. It signals intent and supports claims of accountability. It does not, however, guarantee integration into the routines that shape daily decisions. There exists an ongoing 'implementation gap'. Many organisations have SDG commitment statements, yet they face challenges aligning the SDG goals with their business operations, performance, and resource allocation. Traditional management frameworks often focus more on short-term delivery of outputs and short-term financial indicators, which may undermine attention to long-term implications and social outcomes. There may also be alignments between the goal statements and the outcomes. Some challenges may include resistance to change, limited structural flexibility, and limited resources to invest in building capabilities and measurement



infrastructure. Some organisations tend to use the SDG terminology in a 'symbolic' way, in which the reporting increases, yet the 'logic of the decision' remains the same (Cuesta-Claros *et al.*, 2023).

Organisational behaviour and organisational change provide a set of operational levers to address the above challenge. Organisational behaviour provides insights into what leaders observe, how they perceive pressure, and the trade-offs they make. Organisational behaviour provides insights into how leaders influence norms, values, and organisational culture, which drive organisational behaviour. In contrast, human resource systems provide insights into what becomes organisational routine, including recruitment, development, performance, and reward. Governance systems provide insights into the influence of accountability, which the establishment of oversight expectations and the need for evidence shapes. Research provides insights into the relationships among the integration of the SDG agenda, institutional pressure, and stakeholder scrutiny, which often precede the first adoption (García-Sánchez *et al.*, 2021). Research provides insights into the relationship between good reporting of the SDG agenda, credibility, assurance, and the need for sustained commitments to well-established sustainability practices (Rosati & Faria, 2019). Board structure, composition, and diversity can enhance monitoring, which often provides a broader set of perspectives on sustainability decisions (Taglialatela *et al.*, 2023). These systems are relevant because the integration of the SDG agenda requires procedural compliance, which is insufficient, and calls for integrated thinking on organisational priorities, investment, and credible monitoring.

Evidence also suggests that individual drivers play a role in depth and longevity. Commitments grounded in values and identity can help establish responsibility, especially when owners and senior managers view responsible behaviour as non-negotiable (Patuelli *et al.*, 2022). Knowledge and perceived behavioural control are drivers of managers' ability to align local decisions with global objectives, especially when autonomy is high (Albanese *et al.*, 2023). Education and development can enhance these drivers through decision frames and goal-setting processes that increase behavioural alignment (Cripps & Smith, 2023). These results locate responsible management as a capability that managers can build, rather than a position that firms can take.

Change mechanisms play a critical role in determining whether drivers of behaviour become embedded practices. Evidence shows that alignment improves when organisations adopt the SDGs early in strategy cycles, rather than as a reporting overlay imposed later, after critical strategy choices (Grainger-Brown & Malekpour, 2019; Mhlanga *et al.*, 2018). Reviews of existing SDG tools suggest that most are geared toward mapping and disclosure, with relatively few geared toward strategy work early on (Grainger-Brown & Malekpour, 2019; Mhlanga *et al.*, 2018). Such a challenge helps to explain why enhanced visibility for the SDG agenda might occur without deep-seated shifts in priorities and ambitions (Grainger-Brown & Malekpour, 2019; Mhlanga *et al.*, 2018). More complex implementation approaches that integrate executive mandates and local adaptation can enhance alignment and reach by aligning strategy and operations (Lozano, 2013; Kazanskaia, 2025). Credibility is also contingent on measurement discipline and assurance practices. Poor measurement and strategic disclosure practices can enable and promote greenwashing and a lack of trust, particularly when organisations highlight more positive SDG outcomes and shy away from challenging trade-offs (Scheyvens *et al.*, 2016; Rosati & Faria, 2019). Evidence from case studies also shows how critical leadership and coordination are: policy-supported alignment



and collaboration on the SDGs for an international organisation challenged by resistance and complexity (Montesano *et al.*, 2021); and transformational leadership that supported strategic and cultural shifts toward renewable energy for a large corporation (Madsen & Ulhøi, 2021). Such organisational realities form a distinct educational problem.

Business schools train current and future managers who must make decisions under constraints, ambiguity, and competing priorities. If SDG integration requires governance discipline, leadership judgement, stakeholder engagement, and people-system alignment, then management education must teach these capabilities as practical work. Responsible management education can support this agenda by building SDG literacy that informs managerial decisions and by developing the skills needed to manage trade-offs and redesign systems. This need becomes especially salient in MBA programmes, where learners often hold decision authority and influence organisational practice.

This literature review article examines how an MBA module in Organisational Behaviour and Change can facilitate responsible management and support the embedding of the SDGs within organisations. It synthesises evidence on behavioural drivers across institutional, governance, and individual levels, and evaluates mechanisms of organisational change that shape whether SDG commitments become managed performance. The article also analyses the roles of governance, leadership, and human resource management as an interdependent system that stabilises sustainability into routine action (Rosati & Faria, 2019; Bilderback, 2023). The research focuses on the challenges of implementing the Sustainable Development Goals (SDGs), such as resource limitations, resistance within the organisation, measurement challenges, and the complexity of coordinating the process (Leal Filho *et al.*, 2023). The analysis then uses the evidence to inform the module's principles, including the assessment, with the key instructional anchors being ethical leadership, Green HRM, stakeholder engagement, and integrated performance management (Howard-Grenville & Tsui, 2019; Bilderback, 2023).

Five objectives are discussed in this article. The first objective is to explore the behavioural drivers that contribute to responsible management, aligned with the SDG goals. The second objective is to explore the factors that contribute to integrating the goals into the organisation. The third objective is to explore the factors that contribute to integrating sustainability into the organisation's system through leadership, HRM, and governance. The fourth objective is to explore the factors that contribute to success in different settings. The fifth objective is to provide evidence-based recommendations that educators and managers can apply in practice.

The guiding research questions focus on which behavioural factors enable responsible management aligned with the SDGs; which change strategies support integration; how governance, leadership, and HR contribute to embedding; which barriers and enablers shape outcomes; and which practical steps support durable implementation. This framing positions SDG embedding as an execution problem grounded in organisational behaviour and change. Organisations embed the SDGs when they change how people decide, coordinate, and get held to account. They do not embed the SDGs by merely increasing disclosure. An MBA module that treats SDG integration as core management work can support the shift from symbolic adoption to routine execution by developing the capabilities, discipline, and decision-making quality of future organisational leaders.



This paper's contribution is curricular. It converts the SDG embedding literature into a teachable and assessable pathway for MBAD 828. It specifies what students should produce, how teaching should sequence learning from diagnosis to design, and how assessment can test capability rather than SDG awareness. This contribution addresses the implementation gap by focusing on the managerial routines that sustain SDG performance rather than SDG rhetoric.

1.2. Problem Statement

Despite widespread organisational endorsement of the Sustainable Development Goals, many organisations still struggle to embed the SDGs into governance routines, leadership practice, and human resource systems, with SDG activity often remaining at the level of symbolic reporting rather than routine execution (United Nations, 2015; Rosati & Faria, 2019; Cuesta-Claros *et al.*, 2023). The central problem is a deficit in capability and integration. Organisations often lack the behavioural, governance, and change management mechanisms needed to translate SDG intent into operational decisions, credible measurement, and sustained performance improvement, especially under constraints, competing priorities, and weak standardisation of impact metrics (Leal Filho *et al.*, 2023; Grainger-Brown & Malekpour, 2019; Oliveira *et al.*, 2025). This article addresses this deficit by exploring how an MBA module in Organisational Behaviour and Change can build responsible management capability and support SDG embedding through module design principles and assessment tasks grounded in the research base (García-Sánchez *et al.*, 2021; Howard-Grenville & Tsui, 2019).

1.3. Research Objectives

This article examines how organisational behaviour and change contribute to responsible management and the embedding of the 17 SDGs within organisations.

Research objectives are to:

- Identify behavioural drivers that support responsible management aligned with the SDGs.
- Examine organisational change mechanisms that support SDG integration.
- Analyse the role of leadership, human resource management, and governance in embedding SDGs.
- Evaluate challenges and success factors in SDG implementation across organisational contexts.
- Propose evidence-based recommendations for embedding the SDGs through organisational behaviour and change.

Literature Review

The literature review will investigate the behavioural determinants underlying responsible management in relation to the Sustainable Development Goals (SDGs); the mechanisms of organisational changes, which can enable the integration of the SDGs; the importance of



leadership, human resource management, and governance in ensuring sustainability is ingrained in the organisation; the challenges of implementing the SDGs, which can make the process successful in different organizational settings; and finally, the recommendations on how the SDGs can be ingrained in the organisation through behavioural changes.

Behavioural drivers that support responsible management aligned with the SDGs

The existing literature argues that sustainable management practices aligned with the Sustainable Development Goals (SDGs) are supported by behavioural forces operating at the institutional, organisational, and individual levels. For institutional forces, coercive regulation, government signals, and societal pressures play significant roles in encouraging practice, since public-listed companies are already vulnerable to threats of legitimacy and reputation (García-Sánchez *et al.*, 2021). Pressure from stakeholders further reinforces this factor, since public attention increases the perceived cost of non-compliance. Shareholders' demands and analysts' monitoring further heighten the organisation's focus by linking the company's market value to compliance with the Sustainable Development Goals (García-Sánchez *et al.*, 2021).

At an organisational level, governance enables the organisation to achieve its objectives, primarily by shaping accountability mechanisms and decision-making processes. Board size, composition, and gender diversity are linked to greater focus on environmental SDGs, suggesting that monitoring capacity and diverse perspectives contribute to the quality and sustainability of oversight (Taglialatela *et al.*, 2023). The role of infrastructure in governance adds to this by integrating the SDGs into day-to-day decision-making and non-financial reporting systems through the structure of CSR committees and board specialisation (García-Sánchez *et al.*, 2021). The external assurance role adds to discipline by providing verifiable evidence, reducing reliance on storytelling and increasing the likelihood of linking SDG goals to investment, risk, and performance (Rosati & Faria, 2019).

On the individual level, the interplay between values and capabilities determines both the depth and durability dimensions. Effective behaviour is more stable when top management views sustainability as an identity, a value, and an ethical commitment rather than a matter of mere compliance (Patuelli *et al.*, 2022). SDG awareness and perceived behavioural control play a crucial role in determining management's capacity to connect global goals with decision-making behaviour, especially in situations where management discretion prevails (Albanese *et al.*, 2023). Executive sustainability education strengthens the aforementioned connections, thereby increasing the likelihood of reporting and integration under inconsistent external pressure (García-Sánchez *et al.*, 2021). Responsible management education also encourages self-reflection, thereby improving goal-setting, particularly in terms of behavioural alignment and follow-through (Cripps & Smith, 2023). Executive development is most effective when it focuses on skills for dealing with trade-offs rather than on awareness alone, for instance, in navigating ambiguity (Cripps & Smith, 2023; Azmat *et al.*, 2023).

The literature also shows that context moderates how these drivers combine and how strongly they shape outcomes. Family firms often begin with values-based commitments that precede formal SDG framing, whereas listed firms frequently start with regulatory demands and investor scrutiny (Patuelli *et al.*, 2022; García-Sánchez *et al.*, 2021). Professional communities rely on norms and reputational cues, which can elevate subjective norms and capability beliefs as drivers of engagement (Albanese *et al.*, 2023). Mediators and moderators explain further



variation. SDG awareness can mediate relationships between psychological factors and action by improving feasibility judgments (Albanese *et al.*, 2023). Stakeholder salience can moderate responses to institutional pressure, as organisations differ in their perceptions of which actors are powerful and legitimate (García-Sánchez *et al.*, 2021). Investor sentiment can mediate market responses to SDG signals and shape incentives for disclosure and alignment (Loang *et al.*, 2023). Evidence also cautions against narrow incentive systems. Sustainability-linked CEO pay can associate negatively with SDG integration, signalling the risk that financialised incentives encourage symbolic compliance rather than substantive change (García-Sánchez *et al.*, 2021). This concern aligns with critiques of selective and reputational SDG adoption that fail to alter organisational decision rules (Scheyvens *et al.*, 2016).

Organisational change mechanisms that support SDG integration

The literature frames SDG integration as an organisational change task that requires repositioning the SDGs from external reference points to internal management logics. Integration strengthens when SDGs influence strategy formation, measurement design, governance routines, organisational culture, and stakeholder relationships. Integration weakens when SDGs operate as reporting overlays applied after strategic decisions have already been made. Reviews of SDG tools demonstrate a sequencing limitation. Many tools support mapping and reporting after strategy formation, while fewer tools support early-stage problem definition, prioritisation, and resource allocation (Grainger-Brown & Malekpour, 2019; Mhlanga *et al.*, 2018). This challenge explains the observed phenomenon of Sustainable Development Goals (SDG) adoption potentially increasing without necessarily enhancing ambition, transparency, or implementation (Grainger-Brown & Malekpour, 2019; Mhlanga *et al.*, 2018). Alignment with strategy is the strategic anchoring device. The organisation expresses Sustainable Development Goals strategy in terms of objectives, indicators, and accountabilities using the structured control system of the sustainability balanced scorecard (Rösner & Bredebach, 2022). Alignment with the mission and SMART indicators expresses the strategy in terms of measurable outcomes that units can achieve (Kazanskaia, 2025). Prioritisation frameworks also strengthen integration by requiring organisations to select relevant SDGs and contextualise them by sector and geography, thereby reducing ambiguity and supporting disciplined focus (Berrone *et al.*, 2023).

Implementation design influences whether integration scales and becomes durable. Hybrid approaches combining top-down mandates with bottom-up adaptation appear more effective than single-mode approaches because SDG work requires cross-functional coordination and local process redesign (Lozano, 2013; Kazanskaia, 2025). Governance and accountability mechanisms protect credibility by translating intention into oversight expectations and evidence standards. Earlier SDG reporting links to external assurance and governance diversity, suggesting that governance architecture can determine whether SDG commitments are managed as performance rather than merely aspirational language (Rosati & Faria, 2019). Reporting frameworks and regulatory oversight can improve standardisation and internal demand for verifiable evidence, yet weak metrics and voluntary disclosure can enable selective reporting and greenwashing (Lashitew, 2021; Scheyvens *et al.*, 2016).

Partnership and collaboration support SDG delivery because outcomes often require system-level coordination beyond organisational boundaries. Cross-sector partnerships can mobilise



resources and accelerate implementation, but governance clarity remains necessary because weak coordination diffuses responsibility and weakens accountability (Kazanskaia, 2025). Hybrid organisational forms can mitigate competing institutional logics and manage tensions inherent in sustainability trade-offs, although coordination demands remain high (Bianchi, 2021). Capability building and training address gaps in measurement, stakeholder engagement, systems thinking, and change leadership. Evidence reports benefits from structured training and progress reviews, while other settings report persistent shortages of SDG-focused training as a practical constraint (Bilderback, 2023; Leal Filho *et al.*, 2023). Resource mobilisation shapes durability, with diversified funding reducing vulnerability to shifting priorities and protecting continuity (Kazanskaia, 2025). Policy engagement can strengthen enabling conditions by raising baseline expectations and improving coherence across actors (Kazanskaia, 2025).

Role of leadership, human resource management, and governance in embedding SDGs

The literature presents the system of governance, leadership, and human resource management as a set of interrelated processes that play a critical role in embedding the Sustainable Development Goals. Governance determines the organisational view of what is considered legitimate, measurable, and enforceable, and supports SDG embedding through monitoring and reporting discipline, board composition, and assurance processes (Rosati & Faria, 2019; Martínez-Ferrero & García-Meca, 2020). Increased SDG prominence can be achieved through greater independence and greater distance from governance, which helps monitor and reduce the problem of concentrated decision-making authority (Martínez-Ferrero & García-Meca, 2020). Assurance by external parties helps increase discipline in evidence and reduce flexibility in storytelling, thereby improving internal accountability and credibility (Rosati & Faria, 2019).

Leadership translates governance intent into meaning, priorities, and behavioural expectations. Humanistic, ethical, and transformational leadership approaches align with broader SDG engagement because they shape stakeholder orientation, decision-making norms, trust, and commitment amid trade-offs (Flores *et al.*, 2022; Ronnie, 2024; Purcell *et al.*, 2019; Price *et al.*, 2021). Leadership becomes critical where formal authority is diffuse, and sustainability depends on commitment and cultural mobilisation rather than compliance.

Human resource management operationalises SDG intent by shaping behaviour at scale through people systems. Recruitment and selection can align values and reduce tolerance for harmful conduct. Training and development build competence in measurement, collaboration, and problem-solving. Performance management and rewards can signal that sustainability outcomes matter in daily decisions. Culture-building interventions can strengthen ethical conduct, learning, and psychological safety for raising risks and challenging harmful routines (Bilderback, 2023; Gechbaia *et al.*, 2024; Zaidi & Jamshed, 2021). These HR mechanisms reduce reliance on isolated champions by routinising expected behaviours across roles.

The literature stresses alignment across these mechanisms. Where there is a lack of leadership, effective governance will result in a reporting process driven by compliance, but there will be no behavioural shift. On the other hand, where governance is lacking, effective leadership can generate momentum, but there will be a lack of institutional follow-through. Human Resource efforts without strategic direction or governance can remain unbalanced and



fail to demonstrate quantitative progress (Rosati & Faria, 2019; Lozano, 2013). The moderating variable of context is apparent in the above processes. Within the context of higher education, leadership mobilisation, along with cultural shift, is considered crucial due to the shared governance structure, professional autonomy, and the need for collective progress (Kohl *et al.*, 2021; Purcell *et al.*, 2019). Within the context of the multinational enterprise, the complexity of processes across multiple jurisdictions can increase the importance of a unified assurance process with value-chain responsibility (Van Tulder *et al.*, 2021; Zagelmeyer & Sinkovics, 2019).

Challenges and success factors in SDG implementation across organisational contexts

According to the literature, challenges fall into four categories: resources, capability, governance, and coordination (Leal Filho *et al.*, 2023). The implementation of the Sustainable Development Goals (SDGs) is uneven. It does not meet the standards set by the 2030 Agenda (Leal Filho *et al.*, 2023)—lack of funding limits spending on sustainability projects, measurement, and process improvements. A lack of skills limits analytical skills for planning and reporting (Onyango & Ondiek, 2021; Leal Filho *et al.*, 2023). A lack of infrastructure, including information and communication technology (ICT), is a constraint on monitoring and reporting (Bhaduri *et al.*, 2016; Onyango & Ondiek, 2021).

Organisations also face internal impediments. Resistance to change in culture impedes the adoption and testing of new habits and decision-making rules (Leal Filho *et al.*, 2023). Many organisations have been unable to adopt the language of the SDGs in their operational decision-making habits, thereby perpetuating a divide between plans and actions (Virakul, 2015). The lack of enforcement tools increases the likelihood of tokenistic adoption and selective disclosure (Spangenberg, 2017). Selective engagement persists when organisations choose to adopt SDGs that align with their immediate economic rationale and avoid difficult trade-offs (Jamali *et al.*, 2022). Lack of coordination emerges when organisations are unable to localise globally set targets and their inter-goal dependencies, in which case achievements in some SDGs can negatively affect others if trade-offs are not addressed (Hickmann *et al.*, 2022; Fiandrino *et al.*, 2022).

The success factors are informed by the above limitations and by working as a system. Organisational capacity supports the investment in the workforce, systems, and partnerships, which are crucial to the execution process (Rosati & Faria, 2019). A diverse governance structure, along with external assurance, enhances credibility, which, in turn, improves discipline (Rosati & Faria, 2019). Strategic integration improves execution by requiring organisations to move beyond mapping and to establish an action plan with indicators of progress set in advance (Kazanskaia, 2025; Berrone *et al.*, 2023). Technology integration improves monitoring, ensuring data quality, while training integration improves capability, ensuring the effective execution of the process (Bhaduri *et al.*, 2016; Bilderback, 2023). A partnership with multiple stakeholders leverages resources, but a clear governance structure is crucial to avoid shared responsibility, which can lead to weak accountability (Jaiyesimi, 2016; Kazanskaia, 2025).

Evidence-based recommendations for embedding the SDGs through organisational behaviour and change



Evidence points to a coordinated process that aims to support decision-making, governance discipline, capability development, and learning within organisations. Integrating the SDGs can be improved by implementing disciplined, prioritised, and localised processes within organisations, in which specific SDGs are broken down into organisational objectives (Berrone *et al.*, 2023). Prioritisation eliminates ambiguity and limits the selective use of narratives to gain reputational benefits rather than organisational change (Scheyvens *et al.*, 2016).

Integration of SDGs can take place during strategy formulation rather than afterwards. The integration of the SDGs as inputs for defining a problem, setting goals, or allocating resources addresses a gap in tool-based approaches by prioritising reporting afterwards (Grainger-Brown & Malekpour, 2019; Mhlanga *et al.*, 2018). Management control systems can provide a means of connecting intentions to objectives. The sustainability balanced scorecard framework gives a way to connect SDG goals to objectives, indicators, and responsibilities. SMART indicators provide a framework for conducting a review cycle to facilitate corrective measures (Rösner & Bredebach, 2022; Kazanskaia, 2025).

Governance should be strengthened to protect credibility. Board-level oversight, committee mandates, and assurance requirements increase evidence discipline and reduce the risk of greenwashing, particularly where metrics remain weak (Rosati & Faria, 2019; Martínez-Ferrero & García-Meca, 2020; Lashitew, 2021). Hybrid implementation designs should support scale and local fit by combining leadership direction and resourcing with local process redesign and adaptation (Lozano, 2013; Kazanskaia, 2025). Partnerships should be treated as delivery mechanisms rather than reputational assets and should be governed with clear structures to prevent diffused accountability (Jaiyesimi, 2016; Kazanskaia, 2025).

Capability building should be institutionalised through HR systems. Recruitment, training, performance management, and rewards should reinforce sustainability expectations across roles and reduce reliance on individual champions (Bilderback, 2023; Gechbaia *et al.*, 2024; Zaidi & Jamshed, 2021). Development should prioritise competence for trade-offs and measurement literacy rather than awareness alone (Cripps & Smith, 2023; Leal Filho *et al.*, 2023). Finally, organisations should treat measurement as a learning system. Indicators should link to governance review routines, feedback loops should drive corrective action, and metric quality should improve iteratively. Incentive effects require monitoring because narrow financial incentives can encourage superficial compliance and symbolic alignment (Oliveira *et al.*, 2025; Kazanskaia, 2025; García-Sánchez *et al.*, 2021).

3. Methodology

This article used a literature-review methodology as a systematic, purposive process for locating, selecting, appraising, and synthesising existing research to map knowledge, justify research gaps, and answer the research questions, critically appraising studies, and choosing a narrative synthesis method that matches the review's purpose and the types of evidence (Saur-Amaral, 2014; Turk, 2021; Amjad *et al.*, 2023)

4. Synthesised results

The synthesis results are aligned with the research objectives, namely: behavioural drivers that support responsible management aligned with the SDGs; organisational change



mechanisms that support SDG integration; the role of leadership, human resource management, and governance in embedding SDGs; challenges and success factors in SDG implementation across organisational contexts; and evidence-based recommendations for embedding the SDGs through organisational behaviour and change:

Behavioural drivers that support responsible management aligned with the SDGs

The synthesis indicates that SDG-aligned responsible management follows a multilevel behavioural logic. Institutional pressures often drive adoption because regulations, policy signals, and legitimacy expectations create urgency and raise the reputational costs of inaction (García-Sánchez *et al.*, 2021). Organisational governance then stabilises this early uptake by converting external expectations into internal accountability structures and evidence requirements that influence what decision-makers treat as consequential (Rosati & Faria, 2019; Taglialatela *et al.*, 2023). Individual-level values and capability determine the depth and durability of integration, particularly when external pressure weakens or becomes inconsistent (Patuelli *et al.*, 2022; Albanese *et al.*, 2023). This synthesis therefore emphasises alignment between external expectations and internal identity, because pressure can trigger action, but values sustain commitment under trade-offs and time constraints (García-Sánchez *et al.*, 2021; Patuelli *et al.*, 2022).

The synthesis also clarifies that capability functions as a behavioural driver rather than a technical add-on. SDG literacy and perceived behavioural control influence whether managers interpret SDGs as feasible operational work rather than as aspirational rhetoric (Albanese *et al.*, 2023). Leadership competence in navigating ambiguity and trade-offs strengthens this translation process by enabling decisions that balance short-term metrics with longer-term sustainability goals (Cripps & Smith, 2023). The combined implication is that behaviour changes when organisations align pressure, governance accountability, and managerial capability, rather than relying on any single lever (Rosati & Faria, 2019; García-Sánchez *et al.*, 2021).

Organisational change mechanisms that support SDG integration

The synthesis positions SDG integration as an organisational change problem centred on sequencing. Integration remains superficial when organisations adopt SDG tools that focus on mapping and disclosure after strategy formation because such approaches increase visibility while leaving priorities and resource allocation unchanged (Grainger-Brown & Malekpour, 2019; Mhlanga *et al.*, 2018). The synthesis identifies weak standardisation of impact metrics as a structural amplifier of superficiality, because it enables selective reporting and constrains credible assurance and comparability (Oliveira *et al.*, 2025; Lashitew, 2021). Where incentive systems over-financialise sustainability, symbolic compliance can intensify because rewards become tied to appearances rather than operational transformation (García-Sánchez *et al.*, 2021).

In contrast, the synthesis outlines the integrated change logic associated with substantive integration. The effectiveness of SDG integration is strengthened when organisations integrate the SDGs early in the strategy cycle, align strategic priorities with objectives and indicators, and develop governance frameworks that require accountability and rigorous evidence (Berrone *et al.*, 2023; Rösner & Bredebach, 2022; Rosati & Faria, 2019). Hybrid



implementation approaches, which combine the executive mandate with the need for adaptation at the local level, improve scale and fit, as the implementation of the SDGs requires a combination of strategic guidance and process change tailored to the organisation's specific needs (Lozano, 2013; Kazanskaia, 2025). Cycles of reviews convert measurement into learning and correction, thus contributing to sustainability and preventing the phenomenon of drift, which would confine the activity to disclosure (Bilderback, 2023; Kazanskaia, 2025). Thus, the synthesis distinguishes the SDG adoption outcome of the reporting activity from the strategic decision-making input to the SDG integration process (Grainger-Brown & Malekpour, 2019; Lozano, 2013).

Role of leadership, human resource management, and governance in embedding SDGs

The integration combines the embedding approach with a cascading framework that embraces feedback mechanisms. Governance defines the boundaries of decision-making through oversight, evidence, and assurance, thereby enabling the conversion of aspirational goals into enforceable priorities (Rosati & Faria, 2019; Taglialatela *et al.*, 2023). Leadership makes sense of priorities to assign meaning, prefers stakeholder-focused approaches, and establishes behavioural norms, thus maintaining commitment in the face of uncertainty and conflicting priorities (Cripps & Smith, 2023). Human resource management aligns organisational behaviour with the SDGs to achieve desired behaviour through employee recruitment, training, and cultural interventions (Bilderback, 2023). The synthesis notes observable outcomes arising from misalignment in the cascading sequence. It is important to note that good governance in the absence of leadership promotes reporting and compliance.

Strong leadership without governance can generate momentum but lacks continuity and institutional discipline, especially when leadership changes. HR interventions without clear governance direction often remain fragmented and weakly measured (Rosati & Faria, 2019; Lozano, 2013). This synthesis, therefore, positions embedding as a system-quality issue. SDGs become operational when governance, leadership, and HR mechanisms reinforce one another and send consistent signals about priorities, consequences, and expected behaviours (Rosati & Faria, 2019; Bilderback, 2023).

Challenges and success factors in SDG implementation across organisational contexts

The synthesis indicates that challenges and success factors operate in interacting bundles rather than as isolated constraints. Superficial adoption becomes more likely when resource constraints, weak measurement systems, and limited enforcement combine to make credible monitoring difficult and symbolic reporting attractive (Oliveira *et al.*, 2025; Lashitew, 2021). Coordination challenges also intensify risk because SDG interdependencies require trade-off management and cross-boundary collaboration. Without transparent governance, collaboration diffuses responsibility and weakens accountability (Kazanskaia, 2025). The synthesis therefore emphasises coordination capacity as a cross-cutting constraint that influences both implementation feasibility and the credibility of reported progress (Lozano, 2013; Kazanskaia, 2025).

Success factors also cluster. Organisations strengthen implementation when they combine early strategic integration with governance discipline, credible measurement and assurance, capability building, and structured learning routines (Rosati & Faria, 2019; Kazanskaia, 2025;



Bilderback, 2023). Resource diversification supports continuity and reduces dependence on short-term budgets and single champions (Kazanskaia, 2025). Partnerships can extend capability beyond organisational boundaries, but only when governance clarity prevents diffused accountability and aligns incentives across actors (Kazanskaia, 2025; Bianchi, 2021).

Context effects moderate both challenges and enablers. Family firms can sustain authentic commitment through identity and values even when external pressure is weaker, yet they may still require governance and measurement discipline to demonstrate credible outcomes (Patuelli *et al.*, 2022; Rosati & Faria, 2019). The biggest challenge facing the listed entities is that they can respond easily to regulatory and scrutiny pressures, but they may not become easily disclosure-focused unless governance frameworks and capacity-building mechanisms support integrated practice (García-Sánchez *et al.*, 2021; Rosati & Faria, 2019). Universities and associations increasingly adopt belief-based practices, underscoring the importance of mobilisation and capacity-building initiatives to support these beliefs (Albanese *et al.*, 2023; Kohl *et al.*, 2021). Multinational Corporations face governance complexity, which increases pressure to be consistent and responsible across value chains (Van Tulder *et al.*, 2021; Zagelmeyer & Sinkovics, 2019).

Evidence-based recommendations for embedding the SDGs through organisational behaviour and change

The synthesis integrates the evidence for a pathway focused on execution. Sustainable Development Goal embedding is reinforced for organisations that can localise ambitions early, followed by the strategic formulation of selected Sustainable Development Goals, measured through indicators that inform resource allocation and redesign efforts (Berrone *et al.*, 2023; Rösner & Bredebach, 2022). This stage remedies the sequencing divide in the adoption of Sustainable Development Goal solutions, where SDG disclosure occurs after strategy formation (Grainger-Brown & Malekpour, 2019; Mhlanga *et al.*, 2018).

The system of governance must institutionalise accountability, including the establishment of standards for evidence, to reduce the risk of being misled by greenwashing while maintaining internal controls (Rosati & Faria, 2019; Lashitew, 2021). The management must develop the skills of trade-offs, including establishing decision-making processes that integrate sustainability into the normal performance criteria rather than merely communicating it (Cripps & Smith, 2023). The Human Resource function must institutionalise the agenda, including the alignment of personnel practices, such as recruitment, training, appraisal, and rewards, with the priorities of the SDGs, to reduce the reliance on champions (Bilderback, 2023).

Implementation design must be kept hybridised. The executive mandate must provide resource mobilisation and decisional authority, and the bottom-up process must focus on process change and innovation (Lozano, 2013; Kazanskaia, 2025). Collaborations must be managed as delivery networks, with decision-making authority, to avoid the diffusion of responsibility (Kazanskaia, 2025; Bianchi, 2021). Finally, measurement must be a learning process through cycles of reviewing indicators to guide corrective and iterative improvement, thus enhancing durability and discouraging symbolic compliance (Bilderback, 2023; Oliveira *et al.*, 2025).



5. Managerial implications and recommendations

Managerial implications and recommendations follow directly from the five research objectives. The reviewed evidence shows that SDG integration becomes durable only when managers treat sustainability as a management system. It must shape decisions, incentives, governance, and routines. It cannot sit as a parallel reporting exercise.

Behavioural factors that enable responsible management aligned with the SDGs

The evidence indicates that responsible management emerges from aligned attention, motivation, and capability. External pressure often triggers initial SDG uptake, yet internal values and governance discipline determine whether practice becomes substantive (García-Sánchez *et al.*, 2021; Rosati & Faria, 2019). Managers, therefore, cannot rely solely on voluntary commitment. They need deliberate behavioural design.

First, managers must treat attention as a scarce resource. Boards and executives signal what matters through what they measure, review, and fund. Governance mechanisms and assurance increase internal discipline by moving SDGs from aspirational language into consequences and scrutiny (Rosati & Faria, 2019; Tagliatela *et al.*, 2023). Second, managers must protect intrinsic motivation. Evidence warns that narrow financialisation of sustainability, including some sustainability-linked CEO pay designs, may encourage symbolic compliance rather than deep integration (García-Sánchez *et al.*, 2021). Managers should therefore balance extrinsic incentives with values-based leadership and professional identity work (Cripps & Smith, 2023). Third, managers must build perceived behavioural control. SDG awareness and capability beliefs influence sustainable action, particularly when autonomy is high, and routines remain ambiguous (Albanese *et al.*, 2023). Training and leadership development should therefore focus on decision-making under trade-offs, rather than on awareness-raising (Azmat *et al.*, 2023; Cripps & Smith, 2023).

Managers should institutionalise behavioural enablers through three actions. First, build SDG literacy that links to role decisions, using scenario planning and decision cases tied to real organisational processes such as procurement, project approval, and risk escalation (Albanese *et al.*, 2023). Second, design incentives that reward outcomes and integrity, while avoiding metric systems that invite gaming or cherry-picking; additionally, incorporate assurance and auditability to reduce narrative substitution for evidence (Rosati & Faria, 2019; Lashitew, 2021). Third, strengthen values alignment at the leadership level by using selection, development, and coaching to embed ethical judgment and stakeholder responsibility as performance expectations (Cripps & Smith, 2023; Doh & Quigley, 2014).

Organisational change strategies that support SDG integration

Change strategies support SDG integration when they intervene early in the strategy cycle. Evidence shows a consistent gap. Organisations often adopt tools for mapping and reporting after the strategy has been formulated. This sequencing accounts for high SDG visibility despite limited changes in ambition or operational priorities (Grainger-Brown & Malekpour, 2019; Mhlanga *et al.*, 2018). The implication is that managers must treat SDG integration as planned organisational change rather than as communication. They need hybrid change designs that combine top-down mandate with bottom-up adaptation. Top-down work secures



resources and decision rights. Bottom-up work generates local innovation and practical fit (Lozano, 2013; Kazanskaia, 2025). Managers also need robust measurement systems because weak metrics enable superficial adoption and pose credibility risks (Oliveira *et al.*, 2025; Lashitew, 2021).

Managers should deploy five change strategies as a coherent package. First, embed SDGs into strategic problem definition and prioritisation by selecting and contextualising relevant SDGs, then translating them into strategic objectives before project and budget decisions lock in the operating model (Berrone *et al.*, 2023; Grainger-Brown & Malekpour, 2019). Second, apply structured management controls, such as sustainability balanced scorecards or analogous frameworks, to link goals to indicators, owners, and review cycles (Rösner & Bredebach, 2022). Third, establish hybrid implementation governance, including cross-functional implementation teams with clear mandates, while maintaining executive sponsorship and board oversight (Lozano, 2013; Rosati & Faria, 2019). Fourth, institute robust feedback loops via routine progress reviews that link indicator movement to corrective action, rather than to narrative updates (Bilderback, 2023; Kazanskaia, 2025). Finally, institutionalise learning and knowledge management by codifying SDG-related knowledge into procedures and toolkits to reduce reliance on individual champions (Niesing *et al.*, 2012).

Roles of leadership, HR management, and governance in embedding sustainability

The evidence positions governance as the structural base, leadership as the translating force, and HR management as the operational engine. Governance affects SDG uptake through oversight, independence, diversity, committee structures, and assurance practices that increase accountability and transparency (Martínez-Ferrero & García-Meca, 2020; Rosati & Faria, 2019). Leadership shapes meaning, culture, and stakeholder orientation. Humanistic, ethical, and transformational leadership approaches are associated with broader engagement with the SDGs because they shift decision-making away from short-term metrics (Flores *et al.*, 2022; Ronnie, 2024; Purcell *et al.*, 2019). HR management embeds SDGs through recruitment, training, performance systems, and fair reward practices that support decent work and responsible conduct (Bilderback, 2023; Gechbaia *et al.*, 2024). The managerial implication is that leaders should avoid isolated interventions. Strong leadership with weak governance produces enthusiasm without institutional durability. Strong governance with weak leadership produces compliance without transformation. Strong HR initiatives without strategic alignment produce fragmentation.

Managers should operationalise this triad as follows. First, assign board-level oversight of the SDGs, require external assurance for material sustainability indicators, and integrate the SDGs into risk management and capital allocation reviews (Rosati & Faria, 2019; Ahmed, 2023). Second, make trade-off decisions visible: leaders should model consistent decision-making under pressure and treat stakeholder input as a strategic resource rather than a reputational tactic (Doh & Quigley, 2014; Howard-Grenville & Tsui, 2019). Third, embed SDGs in job design, recruitment, leadership development, and performance management, while linking reward fairness and ethical conduct to the priorities of SDG 8 (decent work and economic growth) and SDG 16 (peace, justice, and strong institutions) (Bilderback, 2023; Ronnie, 2024).

Challenges and success factors that influence SDG implementation



The evidence clusters challenges into resource constraints, organisational resistance, measurement limitations, and coordination complexity. Financial and capacity constraints limit implementation capacity, particularly for measurement and reporting quality (Leal Filho *et al.*, 2023). The lack of strong accountability within the overall SDG framework creates opportunities for symbolic adoption, especially in situations where external accountability is limited (Spangenberg, 2017). There are interconnections among the SDG goals, and these may pose challenges to achieving success if the manager treats the goals as separate objectives (Fiandrino *et al.*, 2022). The success factors incorporate these challenges. Strong governance discipline, accurate measurement, long-term commitment, overall training, and partnerships strengthen the movement towards achieving the goals (Rosati & Faria, 2019; Farrugia *et al.*, 2021; Bilderback, 2023). Early strategic integration is essential because it prevents SDGs from becoming post hoc reporting overlays (Grainger-Brown & Malekpour, 2019).

Managers should address barriers through targeted risk controls. First, ring-fence implementation capacity by funding data infrastructure, training, and process redesign as core organisational infrastructure rather than discretionary expenditure (Leal Filho *et al.*, 2023). Second, surface resistance early through structured dialogue and clear role definitions, while linking resistance management to redesign of conflicting KPIs and overloaded roles (Lozano, 2013). Third, reduce the risk of greenwashing through standardised metrics, audit trails, and external assurance, avoiding selective SDG narratives and requiring justification for SDG scope decisions (Lashitew, 2021; Scheyvens *et al.*, 2016). Finally, use cross-functional governance to manage SDG trade-offs and to align incentives across units and value chains (Fiandrino *et al.*, 2022).

Practical steps to embed SDGs through organisational behaviour and change

Practical embedding requires translation into routines. Managers should treat SDG integration as a shift in operating logic. The evidence supports a staged approach that begins with prioritisation, proceeds to governance and leadership alignment, and then institutionalises change through HR systems, measurement, and continuous learning (Berrone *et al.*, 2023; Rosati & Faria, 2019). Managers also need to close the strategy-tool gap by strengthening early-stage SDG integration, where the most consequential decisions are made (Grainger-Brown & Malekpour, 2019). According to the literature, a coherent managerial roadmap comprises 10 steps.

1. Prioritise SDGs based on material impact, sector context, and stakeholder salience.
2. Translate priorities into a small set of strategic objectives with owners and timelines.
3. Integrate objectives into budgets, investment decisions, and risk reviews.
4. Establish board oversight and executive accountability, supported by assurance.
5. Build hybrid implementation teams that link top management direction with bottom-up redesign.
6. Redesign performance systems so incentives do not reward harmful trade-offs.



7. Build capability through targeted training that focuses on decision practice and measurement.
8. Codify knowledge into procedures, toolkits, and standard operating routines.
9. Build partnerships where outcomes depend on shared systems, including supply chains and communities.
10. Run quarterly learning cycles that review indicators, diagnose variance, and adjust practice.

This set of implications and recommendations reframes SDG work as managerial work. It requires leadership discipline, HR system design, and governance credibility. It also involves changing methods that embed new behaviour into daily routines, where organisational impact forms.

6. Conclusions

SDG adoption often stays at the disclosure level. Durable SDG contribution requires changes in behaviour, governance, and operating routines. Organisational behaviour and change provide the managerial levers for this shift.

An MBA module in Organisational Behaviour and Change should treat SDG integration as core management work. Learners should practise SDG prioritisation, stakeholder mapping, and trade-off analysis through organisational cases. Teaching should connect ethical leadership, board oversight, assurance, and people systems. Assessment should require a change plan with targets, indicators, decision rights, and review cycles. Students should also design HR interventions across recruitment, development, performance management, and culture.

The synthesis points to a simple integration logic: align external expectations with internal organisational values; embed accountability through governance, measurement, and assurance mechanisms; and build capability through focused development programs and institutional knowledge systems. Educators who align module content with this logic equip graduates to deliver responsible management in complex organisational settings. Future research should empirically test the effects of modules on learners' decision quality and managerial practice. Longitudinal studies should track behavioural changes, governance quality, and SDG performance indicators across cohorts and partner organisations.



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Exploring the role of organisational behaviour and change in advancing sustainable development and responsible management

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Abstract

This research explores the application of organisational behaviour and planned change to promote sustainable development, examining the mechanisms underlying their roles in fostering responsible management practice. A systematic review of peer-reviewed literature published between 2020 and 2025 was used to examine the application of organisational practices in integrating the United Nations' 17 Sustainable Development Goals (SDGs). This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure transparency and traceability of the systematic review process. Over 500 records were generated from the systematic search of the five databases used in the research. However, after evaluating the records to ensure they met the systematic review criteria, 22 records were selected for the complete analysis. The final analysis was conducted across corporate, nonprofit, and educational settings, where the vast majority of the systematic review literature examined SDGs related to energy, employment, consumption, and climate change. From the systematic review, the pattern is clear: the SDGs are best incorporated in organisations where enablers support their drivers. While ethical leadership, human resource management systems, and culture underlie the daily activities of the SDGs, reform of governance and social frameworks provide the structured environment of the SDGs. The key takeaway is clear: the SDGs should be incorporated into organisations that invest continuously in ethical leadership and governance reform. This approach supports translating commitment into operational practice.

Keywords: ethical leadership, governance reform, green human resource management, organisational behaviour, organisational change, sustainable development goals

Introduction

Background

This paper examines how organisational behaviour and planned change support responsible management and the integration of the United Nations Sustainable Development Goals within organisational practice. The paper reports a systematic review of peer-reviewed studies published between 2020 and 2025 and applies a PRISMA-guided selection process. The synthesis links behavioural drivers, leadership, culture, human resource management, governance, and change mechanisms to explain conditions that enable or constrain sustained SDG embedding. The paper is structured as follows: the following section outlines the conceptual foundations that frame the review; the methodology section details the search strategy, screening process, and synthesis approach; the findings section presents the



evidence map and the thematic results; the discussion interprets implications for responsible management and SDG integration; and the final section provides recommendations and identifies limitations.

Problem Statement

The adoption of the United Nations 2030 Agenda placed organisations at the centre of a global effort to address inequality, climate disruption, and unsustainable economic practices. Governments can commit to global agreements, yet organisations determine whether the SDGs become real through routine decisions in firms, universities, and non-profits (Sachs *et al.*, 2022). Sustainability language has become common, but implementation remains uneven. Some organisations show measurable progress. Many others remain at the level of policy statements and polished reporting, with limited change to the routines, incentives, and accountabilities that shape everyday operations. Scholars describe this pattern as a delivery gap between aspiration and practice (Alkan & Kamaşak, 2023). A plausible explanation for this gap lies in dominant management models that prioritise short-term returns and efficiency over long-term resilience. Hierarchical structures and narrow performance indicators can discourage collaboration and experimentation, even though both are essential for embedding the SDGs into organisational practice (Montesano *et al.*, 2023). In this context, sustainability efforts tend to be layered on top of existing strategies rather than transforming the organisation's operating model. This type of bolt-on strategy is likely to safeguard the business's reputation. However, it is unlikely to bring about any changes in the desired behaviours needed to deliver sustainable outcomes in environmental or social domains (Cuesta-Claros *et al.*, 2023).

Recent studies highlight emerging impediments that recur across settings. Cultural impediments play a crucial role because employees and management can be resistant to change if it interferes with established cultural patterns and power structures (Ronnie, 2024). Structural impediments play a significant part because budget limitations, especially in developing countries, mean that sustainability must compete with other pressing needs (Palea *et al.*, 2025). A lack of good governance further contributes to the problem. If the boardroom and management fail to hold sustainability performance to the same level of accountability as financial performance, sustainability loses steam (Mariani *et al.*, 2022). These impediments do not occur uniformly but differ across industries, government regulations, and company sizes (Mendy & Al Ghanem, 2025).

A case in point is South Africa, which is highly diverse. Many organisations are committed to the SDGs related to clean energy, decent work, and responsible consumption, especially SDGs 7, 8, and 12. However, evidence suggests the implementation is irregular. Medium-sized organisations cannot transform their supply chains or install renewable energy. There may also be poor and uneven governance standards, which can impede the consistent implementation of sustainability regulations (Mankgele, 2025). Cultural factors may worsen the situation. Hierarchical management and functional silos impede cross-functional learning and implementation, which are needed to achieve the SDGs (Mawutor *et al.*, 2025).

This gap, in which the usual management practices are unable to translate commitment to the SDGs, characterises the problem this review seeks to solve. The organisations are aware of



the objectives and their importance; the hard part is to incorporate the commitment to the SDGs in their usual management practices. Without strategies to influence behaviour and manage change within the organisation, the commitment to sustainability becomes little more than an intention. This review examines studies on how behavioural factors and organisational changes can influence responsible management and, in turn, enhance the integration of the SDGs.

Research Objectives

This article examines how organisational behaviour and change contribute to responsible management and the embedding of the 17 SDGs within organisations.

To achieve this, the study sets out five objectives:

- Identify behavioural drivers such as leadership orientation, cultural values, and motivational factors that shape SDG adoption.
- Analyse organisational change strategies, including governance reforms and stakeholder engagement, that support integration.
- Evaluate the role of human resource management in enabling sustainable practices.
- Compare sectoral and contextual differences in implementation challenges.
- Develop recommendations for organisations to strengthen their integration of the SDGs.

2. Literature Review

Organisations embed the SDGs when responsible management becomes the norm rather than merely an annual reporting cycle. Organisational behaviour explains how managers and employees interpret the SDGs, choose priorities, and act under pressure. Organisational change refers to how an organisation redesigns governance, systems, and routines to ensure that SDG-aligned behaviour persists over time. The evidence indicates that SDG integration strengthens as organisations shift from peripheral adoption toward normative integration, in which the SDGs influence organisational purpose and identity, not only projects and disclosures (Berrone *et al.*, 2023; Jimenez *et al.*, 2021).

Advancing sustainable development and responsible management in organisations relies on complementary theoretical lenses that together link strategy, systems, and behaviour to planned change: a natural-resource-based view explains how environmental strategies (pollution prevention, product stewardship, sustainable development) and associated capabilities become sources of competitive advantage and inform managerial responsibility for ecological constraints (Hart 1995; Hart & Dowell 2010); dynamic capabilities research specifies how firms purposefully sense, seize, and reconfigure resources for sustainability performance, offering constructs and measures to operationalise sustainability-oriented capability building (Buzzao & Rizzi 2020); paradox theory frames intrinsic tensions across the triple bottom line and shows that paradoxical cognition and strategies can enable superior social and environmental outcomes under complexity (Carmin & De Marchi 2022); institutional and stakeholder perspectives account for external pressures and interactive responses, including how field-level institutionalisation reshapes the CSP–CFP relationship and why stakeholder engagement is central to sustainability strategy and learning (Brower &



Dacin 2020; Sharma & Starik 2004); sustainability transitions scholarship provides a multi-level, socio-technical lens (niches–regimes–landscapes) and governance approaches to steer long-term, cross-actor transformations beyond single firms (Loorbach, Frantzeskaki & Avelino 2017; Geels 2018); organisational behaviour theories of pro-environmental action, notably the theory of planned behaviour and value–belief–norm models, identify attitudinal, normative, and control determinants of employee green behaviour to design effective interventions (Yuriev, Boiral & Guillaumie 2020; Oreg & Katz-Gerro 2006; Stern *et al.* 1999); planned change models emphasise anchoring sustainability changes, extending beyond a simplistic unfreeze–change–refreeze, by addressing multi-level factors that sustain or erode change and by using collaborative evaluation to embed practices (Buchanan *et al.* 2005; Manchester *et al.* 2014; Cummings, Bridgman & Brown 2016); and integrated treatments in corporate sustainability further connect these lenses with leadership and organisational learning to guide responsible management practice (Benn, Edwards & Williams 2014).

Behavioural drivers shaping SDG adoption

The literature points to three behavioural drivers that shape SDG adoption and responsible management conduct. Often, these drivers occur together, and their relative weight is context-dependent and industry-dependent. However, the evidence suggests that a single factor rarely drives the adoption of the SDGs; more often, several factors pull an organisation's behaviour in several directions. Legitimacy motives matter in the adoption of the SDGs, as organisations attempt to gain acceptance from their stakeholders and manage reputational risk. They also seek access to resources such as capital, customers, and partnerships. Empirical findings suggest that larger and more visible organisations, as well as those in high-impact sectors, report on their involvement in the SDGs more proactively. This aligns with the concept of legitimacy, as greater public visibility increases scrutiny and stakeholder demands (García-Sánchez *et al.*, 2021). From a legitimacy perspective, adopting the SDGs could increase their visibility and lead to selective engagement, in which organisations view the SDGs as a communication tool rather than a strategic agenda (Weerasinghe *et al.*, 2025).

Moral and ethical imperatives underlie SDG alignment as leaders emphasise their obligation to society and future generations in terms of sustainability. In higher education institutions, leaders have been observed to emphasise SDG activities as part of their social mandate to produce knowledge and train future leaders, thereby ensuring ethical legitimacy for SDG alignment (Serafini *et al.*, 2022; Kang & Xu, 2018). Generally, ethical leadership provides a moral compass for aligning with the SDGs in an organisational setting by promoting good leadership and inhibiting destructive leadership practices that undermine decent work and institutional justice (Ronnie, 2024).

Efficiency motivations drive the adoption of the SDGs, as organisations view sustainability as an innovation and risk-management opportunity. This is especially true in industries characterised by resource scarcity and regulatory constraints, including tourism, hospitality, logistics, and transportation. In these industries, management embraces the SDGs to benefit from potential cost savings and market opportunities (Aligning ESG, SDGs, and Firm Performance, 2025; Darwisman *et al.*, 2025). Efficiency motivations may promote integration if they are embedded in the organisation's operating activities. They remain limited when organisations treat sustainability as a side project rather than a management discipline



embedded in performance, investment, and accountability. These behavioural drivers interact with leadership orientation and cultural values. Leaders shape which motive dominates. Humanistic and ethical leadership orientations tend to broaden SDG engagement by foregrounding stakeholder dignity and long-term value, whereas purely instrumental orientations tend to narrow it to what is measurable and reputationally valuable (Flores *et al.*, 2022; Ronnie, 2024). Cultural values also matter because they shape what employees treat as legitimate conduct, especially in environments where formal monitoring remains limited. The evidence highlights that toxic leadership can act as an institutional barrier that neutralises otherwise sound sustainability systems, including HR interventions (Ronnie, 2024).

Organisational change strategies supporting SDG integration

Organisational change strategies support SDG integration by redesigning the organisational system that shapes behaviour. The evidence highlights four change strategies that repeatedly enable embedding across sectors. Governance reform provides structure and staying power. Organisations strengthen SDG integration when boards redesign oversight through CSR committees, board specialisation, and more explicit allocation of responsibility for sustainability performance (García-Sánchez *et al.*, 2021). Governance redesign also improves SDG integration when organisations align sustainability with internal decision rights and management processes rather than treating it as an external relations function. In university contexts, whole-institution approaches are most effective when governance integrates value, strategy, partnership, and transparency into management routines (Kang & Xu, 2018; Serafini *et al.*, 2022).

Strategic integration provides direction and coherence. SDG embedding fails when managers attach the SDGs after strategy formation. It succeeds when leaders prioritise relevant goals, contextualise them to industry and community realities, and integrate them into core strategy, budgeting, and performance review (Berrone *et al.*, 2023). The evidence also distinguishes levels of integration. Normative integration, where SDGs shape organisational identity and purpose, yields more substantial outcomes than purely operational adoption focused on isolated initiatives (Sasaki *et al.*, 2023; Jimenez *et al.*, 2021).

Stakeholder engagement enables legitimacy and implementation capacity. SDG outcomes often depend on actors beyond the organisation, including suppliers, communities, local government, and civil society. Multi-stakeholder participation strengthens embedding by improving decision quality and legitimacy and by enabling resource pooling and shared problem-solving (Ordonez-Ponce *et al.*, 2021; Farrugia *et al.*, 2021). Local sustainability partnerships help businesses connect local action to global goals and enable smaller organisations to contribute through collaboration rather than through complex internal systems (Ordonez-Ponce *et al.*, 2021).

Benchmarking and disciplined measurement reduce ambiguity in sustainability work. Organisations also use external systems, such as the GRI Standards or ESG systems, to track progress and compare results across units or with other organisations (ElAlfy *et al.*, 2021). This system provides a consistent definition and indicators, making it easier to move from general commitments to specific demonstrations. Assurance also provides an added level of integrity, encouraging management to create its own internal evidence because statements



have to pass an independent assessment. This also limits greenwashing because it becomes more expensive to make unsubstantiated claims or engage in poor disclosure practices (ElAlfy *et al.*, 2021). However, the literature also indicates inconsistent measurement across sectors.

It suggests that leaders should treat measurement capability as a priority for organisational development. They should view it as a capability to build through systems, roles, skills, and routines, rather than as a narrow reporting requirement (Talwar *et al.*, 2023; Aligning ESG, SDGs, and Firm Performance, 2025).

The role of HR management in enabling sustainable practices

Human resource management operates as a direct lever because it shapes who enters the organisation, what people learn, what gets rewarded, and what behaviour becomes normal. The evidence positions Green HRM as a central framework that links HR interventions to SDG outcomes in specific and practical ways (Anshima *et al.*, 2024). Recruitment and selection support SDG embedding when organisations practice inclusive hiring and diversity programmes that reduce inequalities and recruit individuals aligned with organisational sustainability values (Geradine & McWha-Hermann, 2024). These actions directly align with SDG 10 and strengthen the ethical climate that supports SDG-aligned conduct.

Training and development support SDG embedding by building sustainability literacy, ethical decision-making capability, and practical implementation skills. Workforce awareness and skills development appear particularly important in sectors with large environmental footprints, such as logistics and transportation, where SDG implementation requires operational transformation rather than symbolic commitments (Darwisman *et al.*, 2025). HR can also institutionalise sustainability competencies by embedding sustainable performance metrics into career paths and evaluations through HR information systems (Darwisman *et al.*, 2025). Performance management and reward systems support SDG embedding when they align evaluation and reward with sustainability outcomes and treat fairness and decent work as central outcomes rather than compliance concerns.

Evidence from international NGOs shows HR managers act as custodians of fair reward through different role orientations, including visionary, gatekeeper, and technical consultant roles, each with distinct influence strategies (Geradine & McWha-Hermann, 2024). This challenge matters because credible SDG embedding depends on internal justice. Employees are less likely to support sustainability agendas when they experience unfairness in how the organisation allocates rewards, recognition, and workload. Within these contexts, sustainability could be viewed as performative and not related to the day-to-day management of individuals. The impact of human resources depends on the leadership environment in which they operate. Sustainable leadership is the source that empowers human resources to influence behaviours and create accountability. Toxic leadership decreases the impact of human resources, creates a culture of toxicity, and creates institutional obstacles that human resource interventions alone cannot remove (Ronnie, 2024).

Sectoral and contextual differences in implementation challenges



The challenges of implementation are sector-specific, depending on the types and institutions. The literature, therefore, recommends against generalisation. The managers are expected to assess their institution and design SDG integration in accordance with the capabilities and maturity levels of governance and stakeholder engagement. The challenge in large corporations is not gaining access but coordinating and building credibility. Large corporations have the capabilities and capacity for structured ESG reporting and technology-based measurement systems. The significant challenges are aligning across units, managing measurement and claim inconsistencies, and establishing internal credibility for claims (García-Sánchez *et al.*, 2021; ElAlfy *et al.*, 2021). Small- and medium-sized businesses face other challenges. Budget and capacities are limited, and there are challenges in structured reporting and governance systems. However, there is potential for contribution. The literature shows that SMEs use informal systems, operational improvements, and community or network engagement to exceed capabilities (Ordoñez-Ponce *et al.*, 2021; Palau-Pinyana *et al.*, 2023).

Logistics and transportation face high initial investment costs for sustainability transitions and intense environmental footprint pressures, which make capability and systems transformation decisive (Darwisman *et al.*, 2025). National and regional contexts also shape implementation. Country-level institutional pressures influence adoption decisions, and external accountability mechanisms, such as analyst monitoring and investor demands, strengthen engagement when regulatory and institutional frameworks support them (García-Sánchez *et al.*, 2021). In contexts with weaker external pressure, internal enablers such as CEO sustainability training and board-level CSR expertise become more decisive (García-Sánchez *et al.*, 2021).

Recommendations to strengthen SDG integration

The synthesis supports a set of recommendations that align with the five objectives and respond to the evidence on drivers, change strategies, HR levers, and contextual variation.

First, organisations should prioritise SDGs based on material impact and strategic relevance, then contextualise targets to sector and community realities. This step reduces ambiguity and limits selective adoption driven only by reputational advantage (Berrone *et al.*, 2023; Palau-Pinyana *et al.*, 2023).

Second, organisations should embed SDGs at the normative level by integrating SDG intent into purpose, identity, and core management logic. This approach produces more substantial and more sustained outcomes than treating SDGs as operational add-ons (Sasaki *et al.*, 2023; Jimenez *et al.*, 2021).



Third, organisations should implement governance reforms that establish apparent oversight and accountability. Boards should establish CSR committees or equivalent specialisation, build CSR expertise, and strengthen credibility through transparent benchmarking and verification where appropriate (García-Sánchez *et al.*, 2021; ElAlfy *et al.*, 2021).

Fourth, organisations should institutionalise stakeholder engagement through structured partnerships, primarily where SDG outcomes depend on shared systems. Local sustainability partnerships provide a practical pathway for SMEs and place-based organisations to contribute despite resource constraints (Ordonez-Ponce *et al.*, 2021; Farrugia *et al.*, 2021).

Fifth, HR leaders should treat SDG embedding as an HR system design task. They should align recruitment, training, performance management, engagement, wellbeing, and reward fairness with explicit SDG outcomes. They should also protect HR's influence by addressing the risk of toxic leadership and by securing governance support for HR sustainability mandates (Anshima *et al.*, 2024; Geradine & McWha-Hermann, 2024; Ronnie, 2024).

Finally, organisations should select implementation pathways that align with their capacity. Large organisations should use formal governance and structured ESG frameworks. SMEs should rely more on partnership-based capabilities, informal systems, and incremental improvements that are still linked to clear SDG outcomes (Palau-Pinyana *et al.*, 2023; Ordonez-Ponce *et al.*, 2021).

This integrated view positions organisational behaviour and organisational change as complementary. Behavioural drivers explain why organisations adopt and how people act. Change strategies explain how organisations embed those actions into routines that persist. HR functions translate SDG intent into daily work practice. Governance and stakeholder engagement provide credibility and system reach. Sector and context determine which mix of mechanisms works in practice, and they explain why SDG embedding succeeds in some organisations and stalls in others (García-Sánchez *et al.*, 2021; Berrone *et al.*, 2023).

4.Methodology

4.1 Review protocol

This study follows a systematic review protocol guided by the PRISMA 2020 framework, which provides a transparent structure for identifying, screening, and synthesising evidence (Page *et al.*, 2021). The PRISMA approach was selected because it ensures clarity in inclusion decisions and replicability for future researchers

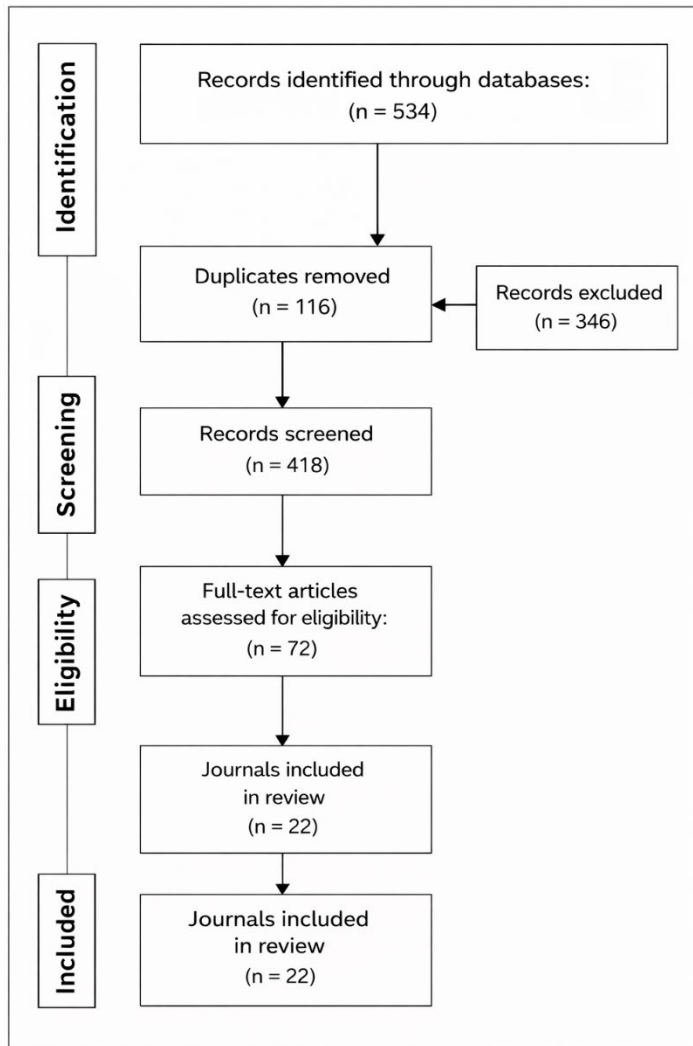


Figure 1: PRISMA framework

4.2. Databases and search strategy

Searches were conducted across five databases: Scopus, Web of Science, Emerald Insight, MDPI, and Google Scholar, which collectively cover management and sustainability literature comprehensively. Boolean operators were used to combine search terms: (“organisational behaviour” OR “organisational change”) AND (“responsible management”) AND (“sustainable development goals” OR SDGs). Filters were applied to restrict the search to peer-reviewed journal articles published in English between January 2020 and June 2025. This period was chosen to ensure that the review captured the most up-to-date research following the UN’s mid-decade review of SDG progress.

4.3. Inclusion and exclusion criteria



Articles were included if they: (1) were published in accredited, peer-reviewed journals; (2) examined organisational settings such as corporations, universities, or NGOs; (3) addressed either responsible management or SDG integration; and (4) presented empirical evidence or substantial conceptual frameworks. Articles were excluded if they: (1) were editorials, or grey literature; (2) focused on household or individual-level sustainability practices; or (3) lacked explicit reference to organisational behaviour or change.

4.4. Screening and selection

The initial AI-prompt search yielded more than 500 records. After duplicate removal, 418 remained for title and abstract screening. Of these, 72 articles were reviewed in full text, with 22 meeting the inclusion criteria. Reasons for exclusion at the full-text stage included a lack of focus on organisational aspects, absence of SDG context, or insufficient methodological rigour.

4.5 Data extraction and quality appraisal

The data from each included study were extracted using a standardised form that captured information such as the authors' names, the year of publication, the country or region, the sector or context, the SDGs being addressed, the methodology, and the main findings. A table was created to facilitate comparison of the studies. Quality assessment was conducted by examining the research design, the sample adequacy, and the validity of the conclusions. Only peer-reviewed articles were considered to reduce the risk of poor-quality information.

4.6 Synthesis approach

The synthesis process used an integrated approach combining descriptive mapping and thematic synthesis to synthesise evidence from both conceptual and empirical research. The descriptive mapping helped ensure a systematic view of evidence development, and thematic synthesis enabled the integration of evidence from different research in a transparent and interpretive process (Thomas & Harden, 2008). The process followed a systematic coding logic that adhered to traditional qualitative research procedures (Saldaña, 2021). The process used open coding, axial coding, and selective coding to move from small pieces of evidence to more general explanations (Strauss & Corbin, 1998).

The first stage involved applying open coding. The data were coded line by line to discern the specific mechanisms of the organisations, the enabling conditions, and the reported outcomes from the studies. The unit of analysis considered the reported data and the interpretations made in relation to them. This approach was necessary because the data analysis stage was still in its early phases and needed to avoid abstraction (Saldaña, 2021). The codes were action-focused and brief to ensure clarity in the analysis. This approach improved coder reliability and traceability in the analysis process (Miles *et al.*, 2014).



The next step was axial coding. Open codes were coded to form higher-level concepts, and relationships among concepts were developed to identify interaction effects among mechanisms. This step mainly focused on conditions, connections, and reinforcement mechanisms, and emphasised the integration of SDG mechanisms through the convergence of behavioural and structural mechanisms. For example, this analysis explored how ethical leadership might enhance the plausibility of HR factors or governance mechanisms to consolidate behavioural change by making sustainability performance reviewable (Strauss & Corbin, 1998). Categories were refined iteratively through constant comparison across studies. The guiding criterion was explanatory contribution, meaning categories were retained when they clarified how and why mechanisms operated, and were revised when they produced conceptual overlap or merely restated descriptive content (Miles *et al.*, 2014).

The third stage involved selective coding and theme refinement. Axial categories were integrated into a small set of core themes that directly addressed the review objectives. Themes were treated as analytic explanations of patterned relationships in the evidence, rather than as broad topical headings. Refinement, therefore, required checks of internal coherence within each theme and distinctiveness across themes, to ensure that each theme captured a unique explanatory mechanism (Braun & Clarke, 2006). Themes were merged when evidence consistently reflected the same underlying process, and themes were separated when the evidence suggested different pathways, boundary conditions, or contextual contingencies (Braun & Clarke, 2006). Candidate themes were also tested against disconfirming instances to limit over-generalisation. Where findings differed by organisational size, sector, or institutional setting, context-dependent variation was retained in the final thematic structure rather than treated as noise (Miles *et al.*, 2014).

4.7 Reliability and validation checks

Several approaches were used to improve the reliability and validity of the analyses. Firstly, a set of studies was independently coded on a common codebook by two different reviewers. Disagreements in coding were clarified and discussed in a structured manner to ensure consistency and avoid coder drift during the synthesis (Campbell *et al.*, 2013; Miles *et al.*, 2014). Secondly, an audit trail was used to record changes to the codebook, decisions on whether to combine or split categories, and justifications for accepting or rejecting themes. These approaches were used to ensure a high degree of transparency and confirmability of the thematic pathway from the evidence to the themes (Lincoln & Guba, 1985; Nowell *et al.*, 2017). Finally, sensitivity analyses were conducted to re-examine the basis of the themes in the literature. This was done to ensure that a few sources did not support the themes and were not implausible across different settings and designs (Nowell *et al.*, 2017; Thomas & Harden, 2008).

5. Systematic literature review findings

5.1 Descriptive overview of the literature

Table 1 provides a descriptive summary of the 22 studies included in the review, followed by a more detailed analysis.



Table 1: Summary of the 22 studies

Category	Sub-category	Number of studies	Notes
Region	Europe	11	Largest share of studies
	North America	5	
	Africa	3	Includes South Africa and Bahrain (developing-country contexts)
	Asia	2	
	Latin America	1	
Sector	Corporate case studies	14	Dominant focus
	Non-profit & higher Education	5	Combined
	SMEs	3	Emphasis on collaboration under resource constraints (Jiménez <i>et al.</i> , 2021)
SDGs most examined	SDG 7 (Clean energy)	—	
	SDG 8 (Decent work & economic growth)	—	
	SDG 12 (Responsible consumption)	—	
	SDG 13 (Climate action)	—	Focus intensely on environmental and labour issues.
Publication trends	Post-2020 surge	—	Reflects increased scholarly interest in SDG initiatives
Study type	Conceptual/review papers	~ $\frac{1}{3}$	
	Empirical (case studies, surveys, etc.)	~ $\frac{2}{3}$	Majority

Regionally, as indicated in Table 1 and Figure 1, most of the literature was drawn from Europe (11 studies) and North America (5 studies), with fewer but notable contributions from Africa (3 studies), Asia (2 studies) and Latin America (1 study). Although Africa remains underrepresented, the inclusion of studies on South Africa and Bahrain provides valuable contexts for developing countries (Mendy & Al Ghanem, 2025; Tsikada *et al.*, 2025).

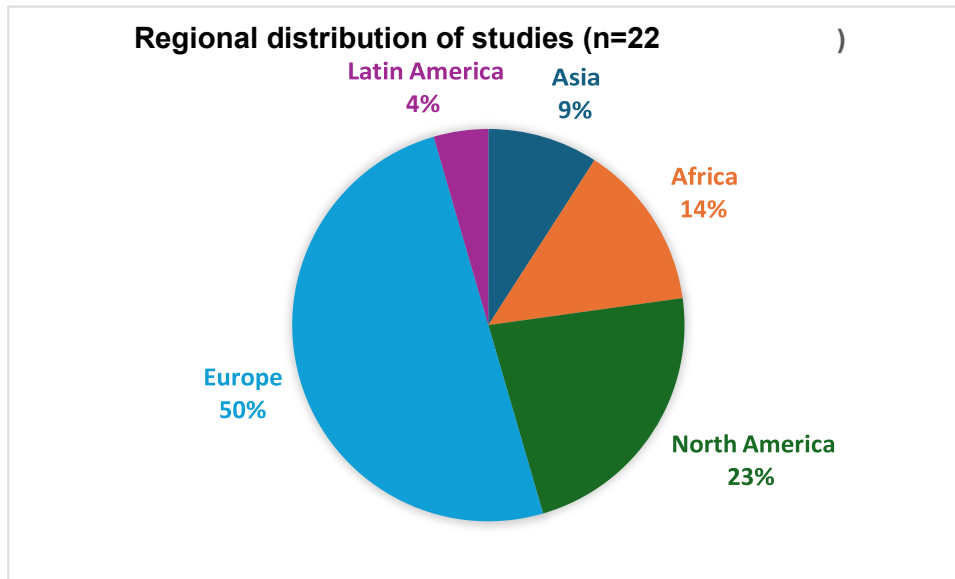


Figure 1: Regional distribution

Figure 2 illustrates that corporate case studies dominate (14 studies), followed by non-profit and higher education institutions (5 studies combined). Three articles explicitly focused on small and medium-sized enterprises (SMEs), often noting that resource scarcity makes SDG adoption more difficult but also forces creative collaboration (Jiménez *et al.*, 2021).

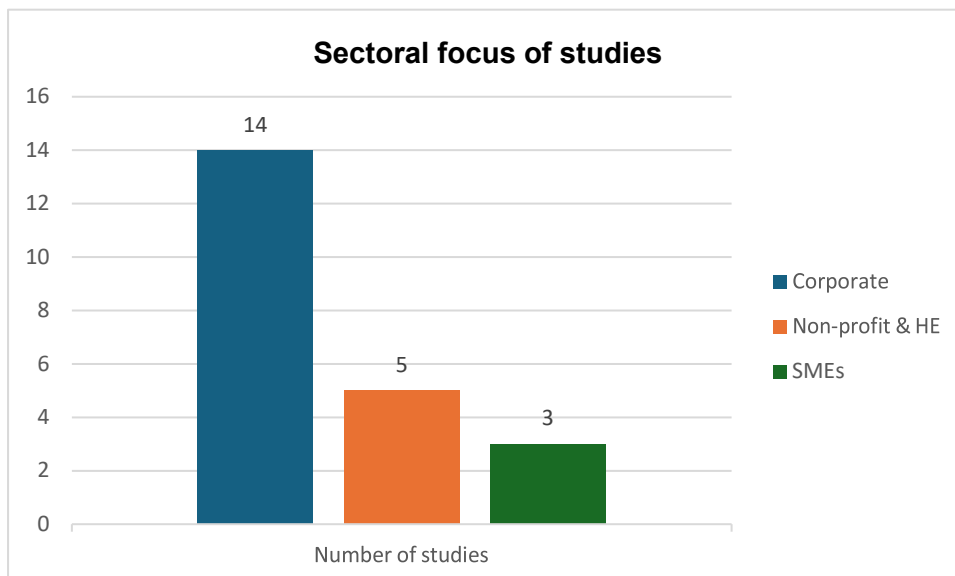


Figure 2: Sectoral focus

As highlighted in Figure 3, the SDGs most frequently examined were SDG 7 (affordable and clean energy), SDG 8 (decent work and economic growth), SDG 12 (responsible consumption and production), and SDG 13 (climate action). This reflects a research emphasis on environmental and labour issues, whereas goals such as quality education or reduced inequalities appeared less frequently.

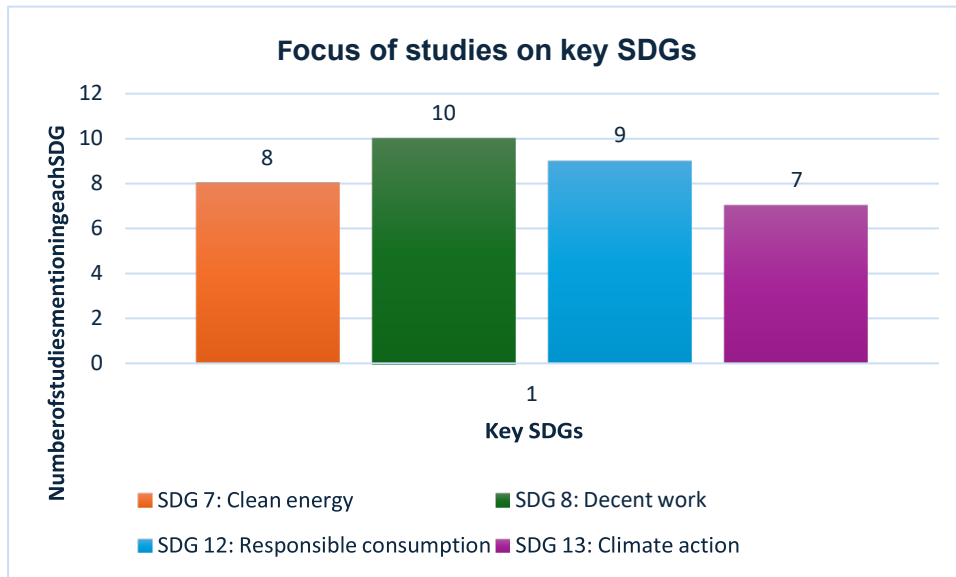


Figure 3: Focus of studies

Figure 4 shows that publication trends indicated a surge after 2020, likely reflecting growing academic interest and the availability of data on SDG initiatives. A notable portion of studies (about one-third) were conceptual or review papers, but the majority provided empirical findings through case studies, interviews, surveys, or document analyses.

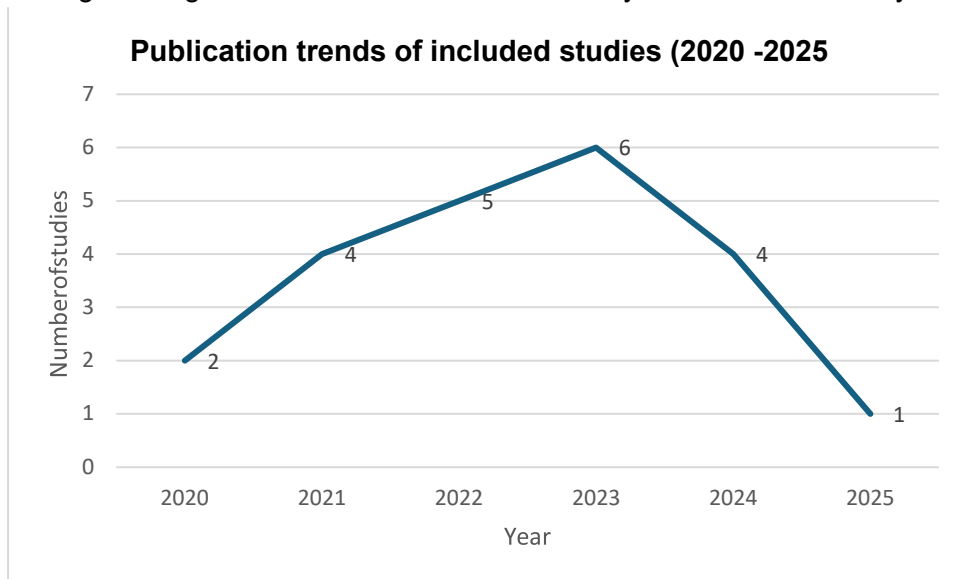


Figure 4: Publication trends

5.2 Thematic synthesis

According to the literature, there are three fundamental forces of organisational engagement with the SDGs: moral, efficiency, and legitimacy. These forces rarely appear in isolation but intersect with one another, with the balance of forces changing depending on the context, industry, or organisational type (Mestdagh *et al.*, 2024).



For example, moral forces are at play where leaders and employees consider sustainability a moral issue. Efficiency forces are at play in the connections between the organisation's SDG-related activities, innovation, competitiveness, and costs. On the other hand, legitimacy forces are at play, with the organisation driven by external demands to maintain its social license (Mestdagh *et al.*, 2024).

These forces can interact with each other, where moral forces can drive efficiency, and external forces can drive innovation, which can eventually result in sustainable value (Mestdagh *et al.*, 2024).

Ethical leadership and culture, in keeping with Objective 1, provide the context in which the credibility and sustainability of SDG integration can be realised. A leader's style establishes the organisational context, indicating what will be reinforced and what will be ignored. Ethical and inclusive leaders can be expected to establish cultures in which sustainability becomes a workaday concern. A good example in this regard is the work of Athanasopoulou *et al.* (2025), which shows that sponsorship behaviours that enabled women's participation led to the achievement of SDG 5 goals, with the target becoming visible in the organisational landscape through significant changes in the organisation's actions and attitudes.

On the negative side, there are also indications that stagnation in achieving the SDGs can be linked to authoritarian and fearful forms of leadership in organisations. A case in point is Ronnie's 2024 work, which shows that in South Africa's workplaces, authoritarian and fearful forms of leadership led to stagnation in achieving the goals of SDG initiatives.

There can be little doubt that when leaders in organisations act in ways that reflect the goals they want to achieve for their stakeholders, the goals will be more likely to be realised in their organisations and that when they act in ways that breed distrust and silence in their stakeholders, the goals will be less likely to be realised in their organisations.

Human resource management, in line with Objective 3, is a tangible tool for translating commitment to sustainability into behavioural outcomes. Human resource management sends out a message on how the organisation measures success. By aligning recruitment, training, performance, and reward with sustainability, the SDGs become part of the employment contract itself.

The importance of aligning recruitment, training, performance, and reward with sustainability is highlighted by how fairness and sustainability values, through HR management, influence employees' perceptions (Geradine and McWha-Hermann, 2024). Training is the other tool that plays a critical role in aligning staff behaviour with sustainability values. Bilderback (2024) indicates that sustainability education aligns staff behaviour and enhances the organisation's public image.

Sustainability and the SDGs have been integrated into the global business dialogue through the United Nations' Sustainable Development Goals (UN-SDGs). By aligning with the SDGs, organisations contribute to the global dialogue on sustainability and the business case for sustainability (United Nations, 2024).



Governance and stakeholder engagement, in line with Objective 2, play a critical role in ensuring SDG initiatives remain resilient amid shifts in leadership focus and budget constraints. Governance is important because it embeds sustainability in established routines. This helps because boards and executive teams that embed sustainability-based monitoring and decision-making processes make it difficult to abandon SDG initiatives (Montesano *et al.*, 2023). This is because, in the absence of embedding in governance structures that view sustainability as secondary, SDG initiatives become dependent on personal networks and stall as soon as leadership focus and budgets shift. Stakeholder engagement enhances governance by adding voice, scrutiny, and collective ownership to the monitoring and decision-making processes. This is because advisory bodies and stakeholder forums, as reported by Mariani *et al.* (2022), embed initiatives into monitoring and decision-making processes, enabling various groups to influence and hold leaders accountable. Such embedding in networks involving SMEs appears to provide collective capacity. As found by Jiménez *et al.* (2021) in Spain, clustering of SMEs enables resource- and risk-sharing strategies. In environments where trust is low, embedding in monitoring and decision-making processes through stakeholder bodies can enhance trust. This was argued by Tsikada *et al.* (2025) in the context of South Africa.

Change management tools, in alignment with Objective 4, are necessary in practice, rather than being the 'beaten add-on'. Sustainability in the change process is doubtful if it is left solely to the project's passion. The order of activities is essential, such as the direction provided in the 'diagnosis', the 'coordination' in planning, and the 'learning loops' in evaluation. The same points are raised in the literature of reporting and measurement. Molinari *et al.* (2025) recommend a staged process for reporting on SDGs 7 and 13, rather than a one-off approach. Talwar *et al.* (2023) recommend a detailed set of indicators for systematic field observation in business schools. The underlying principle in all the above is the use of measurement to ensure the 'SDG activities are not symbolic'. Institutional models and innovation, related to Objective 5, add another level. Many studies highlight the importance of intermediaries and hybrid solutions for scaling SDG outcomes. For example, Mariani *et al.* (2022) point out that non-profit organisations can act as coordinators, bringing people together and maintaining focus, especially when public-sector capacity is limited. Innovation is also found in organisational and technological design. For example, Ranabahu (2020) identifies social enterprises in Colombia that have developed innovative business models to expand their reach and contribute to the SDGs while respecting ethical principles. Technology provides additional opportunities, but only when integrated into organisational practices. Smuts and Van der Merwe (2025) provide an example of using digital platforms to monitor energy consumption and value chains to mitigate greenhouse gas emissions. Strukelj *et al.* (2023) stress the importance of feedback mechanisms in an organisational cybernetic model of sustainability. Taken together, these studies point to an obvious conclusion: that change is not created automatically by tools, but by organisations that use them and implement changes. In sum, this review suggests that organisational behaviour and change are key to embedding the SDGs, shaping what people do and the organisational structures left in place. The enabling conditions are created through ethical leadership and participative cultures, while scaffolding is provided by HR systems, governance structures, and frameworks of organisational change to keep the pace. The moral, efficiency, and legitimacy forces are interrelated in their application, which helps to explain why SDG activities can progress quickly in one place but stagnate in another. However, the data also shows imbalances. There is a lack of



representation of African and Latin American settings, although most studies still focus on energy, labour, consumption, and climate SDGs. There is a lack of consideration of small companies, which are widespread in most economies, especially in the current state of affairs, as noted by Jiménez *et al.* (2021). Thus, the emerging trend is uneven development. This means that applying frameworks is not a one-size-fits-all approach.

6. Discussion of results

This section examines the literature to highlight how organisational behaviour and change facilitate responsible management practices and the achievement of Sustainable Development Goals. The focus here will be on three main areas: traditional accountable governance, understanding organisational behaviour and change, and implementation.

For many years, the conventional management literature has been criticised for adopting an increasingly narrow outlook. This means that efficiency gains, stock market performance, and shareholder value have come to occupy centre stage to such an extent that they limit discussion of broader concerns. This kind of management system tends to have centralised control at the top of the hierarchy and tends to make decisions in a top-down manner. While such a system may work well in the short to medium term to make organisations financially successful, it may make them rigid and less able to adapt to changing circumstances, such as climate change risks and/or social unrest (Montesano *et al.*, 2023). The concept of responsible management has been offered in this kind of scenario. This means that instead of having management fixated solely on profitability, they should seek to integrate their performance in this area with ethical concerns, environmental sustainability, and their accountability to broader society. The point here is that to be more resilient in today's world, organisations will have to consider their performance not only in terms of profitability for their shareholders but also in how they address concerns about inequality and sustainability (Cuesta-Claros *et al.*, 2023). This concept goes beyond semantics; it indicates that management needs to make a real-world adjustment in how they interact with their employees. This means they will have to view their employees, not simply as people they can order around to make changes in their organisations, but rather as people they can work with to make those changes (Ronnie, 2024). This, in turn, means their priorities for change will have to expand to include their stock market performance, aligned with their sustainability strategies. This kind of management can be said to be both a corrective to conventional management and a real-world acknowledgement of the pressure from wider society for organisations to have more than just their profitability at heart.

The literature suggests that organisational behaviour is the cultural context within which sustainability can either flourish or fail. The role of ethical leadership, for instance, is always cited. A leader who is open, consultative, and holds themselves accountable is more likely to build a culture in which commitment to the SDGs becomes business as usual rather than something that happens once a year (Athanasopoulou *et al.*, 2025). On the other hand, leadership based on fear, hierarchy, or exclusion is likely to foster a culture that resists, inhibits, and prevents change (Ronnie, 2024).

Human resource systems also have a significant impact in this regard. Recruitment, promotion, and reward strategies that incorporate sustainability send strong messages about organisational values and goals. Geradine and McWha-Hermann (2024) show that when



fairness and sustainability values are incorporated into HR strategies, employees see them as a core element in defining success rather than just add-ons to success strategies. Training sessions can also promote this position. Organisations that invest in sustainability-focused training and education have seen changes in their staff's actions and have also improved their image in the community, according to Bilderback (2024). While behaviour and culture set the initial conditions, there is only so much they can do on their own to ensure the integration of the SDGs. Numerous studies are showing the importance of a step-by-step approach, which can be achieved through frameworks such as benchmarking, rollout, or regular feedback, depending on the industry (Molinari *et al.*, 2025; Talwar *et al.*, 2023). Different governance systems are not industry-standard but instead industry-dependent. While some industries require the oversight of a board of directors, which can foster accountability, others rely on industry clusters, which allow small businesses access to resources that would otherwise be unavailable (Jiménez *et al.*, 2021).

7. Managerial implications and recommendations

Effective governance has become a viable approach for organisations, compared to approaches that use profit as the standard for measuring organisational success (Cuesta-Claros *et al.*, 2023). Organisational long-term sustainability has come to rely not only on financial performance but also on how organisations respond to pressures related to inequality and sustainability (Cuesta-Claros *et al.*, 2023). More than a naming game, this is a paradigm shift for organisations and a challenge for their strategy and governance. Organisational strategy must be revised so that financial factors align with organisational sustainability objectives, enabling organisations to be held accountable for their activities (Ronnie, 2024). Organisational strategy has also undergone a paradigm shift and needs to be revised so that employees become participants in organisational change rather than mere compliance actors (Ronnie, 2024).

Research on organisational behaviour and change within the context of SDG integration presents the integration of the SDGs as a cultural and behavioural issue, facilitated by enabling systems. From the literature, culture is the foundation on which sustainability can germinate or die. Ethical leadership is a persistent theme, in which leaders who are open, consultative, and self-accountable are more likely to create a culture in which SDG commitments become part of the fabric of everyday life rather than just a periodic reporting exercise (Athanasopoulou *et al.*, 2025). Fear-driven leadership, on the other hand, is more likely to create a culture of pushback, stifle innovation, and hinder learning within the organisation, thereby impairing the organisation's change capability (Ronnie, 2024).

Human resource systems are crucial in ensuring sustainability expectations are met. Recruitment, promotion, performance management, and rewards have high signalling value in determining what is deemed merit within the organisation. Geradine and McWha-Hermann (2024) indicate that HR practices that incorporate principles of fairness and sustainability are viewed by employees as part of what constitutes success in the organisation rather than as added value. Training enhances this process by developing skills and reinforcing values. Bilderback (2024) highlights how sustainability education can alter employee behaviour and enhance legitimacy.



However, behaviour and culture cannot drive the integration of the SDGs on their own. According to the literature, adopting structured, stepwise approaches to implementation rather than a set of unconnected projects leads to faster progress. This often involves benchmarking, stepwise implementation, and feedback cycles, with a mix of approaches depending on the industry type and other factors (Molinari *et al.*, 2025; Talwar *et al.*, 2023). Some forms of governance are associated with sustainability, with the presence of advisory bodies, sector-wide collaborations, industry clusters, or other forms of collective action providing a means of sustaining accountability, where some forms of industry clustering are beneficial to smaller companies, which otherwise lack the capacity to achieve their goals on their own (Jiménez *et al.*, 2021). This suggests a division of labour, where leadership provides the motivational push through organisational values, while governance systems provide the means to turn that push into sustained organisational routines.

The reviewed evidence suggests several implications that can help transform commitment into integration with the SDGs. The implications help organisations adapt based on available context and resources. First, organisations can improve their leaders' capabilities in ethical and inclusive decision-making. The success of sustainability projects can depend on the behaviour of the leader, and thus, improving the skills of the leaders through ethics, transparency, and inclusion, besides management skills, can be very effective, as it helps to ensure the creation of a culture where sustainability is a normal activity, rather than a distinct one (Athanasopoulou *et al.*, 2025). Second, sustainability criteria can be incorporated into HR practices. The areas of recruitment, training, and appraisal provide opportunities to repeatedly reinforce behaviours aligned with the SDGs' priorities. Job analysis, with sustainability criteria incorporated in appraisal, ensures clear criteria. Specialised training in resource use, alongside inclusion, will enhance internal conduct and increase external legitimacy (Bilderback, 2024).

Third, structured frameworks of change can be followed in the implementation process in organisations. Without a structured plan, change initiatives often lose focus, and a staged change process, such as diagnosis, planning, implementation, and evaluation, helps maintain momentum (Molinari *et al.*, 2025). Feedback and learning from best practices through benchmarking enable organisations to learn and improve (Molinari *et al.*, 2025). Fourth, organisations can reassess their governance structures to make credible spaces for participation. Sustainability efforts must not depend on a single individual in the organisation. The boards and executive teams must incorporate sustainability into their ordinary monitoring and assessment. The use of advisory boards and forums can enhance accountability by expanding the voices. Cross-sector collaborations can provide access to knowledge that might not be in-house. Smaller organisations might not have the capacity to make such structures; they can form part of industry groups to enhance resource sharing and build legitimacy (Jiménez *et al.*, 2021). Fifth, organisations can make use of digital technology in a careful and integrated way. While energy consumption or supply chain tracking is useful, it is only useful if organisations use this information for reflection, learning, and adjustment. Digital technology should be part of an overarching sociotechnical system in which people, culture, and technology co-evolve, rather than simply being a tracking device (Smuts & Van der Merwe, 2025).

8. Study's limitations



This study also carries several limitations. The evidence base remains geographically uneven. Studies cluster in Europe and North America, with fewer from Africa and Latin America. This imbalance constrains transferability to settings characterised by resource scarcity and different institutional pressures (Nicolò *et al.*, 2023). The SDG coverage is also uneven. The literature focuses heavily on energy, work, consumption, and climate goals, while areas such as gender equality and peace and justice receive less sustained attention. This focus narrows the understanding of responsible management across the full spectrum of SDGs. In addition, most studies examine large and well-resourced organisations. SMEs receive less attention despite their importance to employment and local development. Future research can address this gap by examining SME SDG implementation in developing economies and employing longitudinal designs to track how change unfolds over several years. Finally, recommended solutions carry risks. Over-reliance on quantitative indicators can encourage box-ticking. Digital monitoring platforms can remain inaccessible for resource-constrained organisations. These constraints require careful adaptation and continuous critical reflection.

9. Conclusions

This systematic review evaluates the extent to which the field of organisational behaviour and the processes of organisational change can be used to support responsible management and the achievement of the Sustainable Development Goals (SDGs). It combines 22 peer-reviewed articles from 2020 to 2025, using the PRISMA protocol to ensure transparency and traceability in the identification, screening, and inclusion of studies.

Findings indicate that embedding the SDGs requires more than an intervention or a linear implementation process. Success requires alignment between behavioural factors and organisational infrastructure. Leadership, organisational culture, and other factors influence what people value, what people will accept, and how people interpret commitments to sustainability. Systems, policies, and governance structures influence what is measured, rewarded, or enforced. Those organisations that align soft factors with infrastructure have a better chance of turning sustainability from talk to practice. In this context, good management is not an agenda running parallel to management but an advanced form of management with an expanded set of success criteria that aligns business operations with collective well-being, encapsulated in the SDGs.

Organisations and societies will need to learn and adapt to the future that is to be reached in 2030, and this will not be possible with one-off solutions. Organisational behaviour and change will continue to play an integral role in this, as they offer the tools needed to shift mindsets and develop sustainable practices.



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Financial Inclusion and SMME Growth in Gauteng: Unlocking Barriers and Opportunities

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Abstract

Financial inclusion is a critical pillar of sustainable economic development, particularly in emerging economies where access to finance shapes the growth and survival of small, micro, and medium enterprises (SMMEs). In South Africa, SMMEs drive job creation, poverty reduction, and innovation, yet they remain marginalized by mainstream financial institutions. This study investigates the opportunities and challenges of financial inclusion for SMMEs in Gauteng province, the country's economic hub. Guided by an interpretivist paradigm, semi-structured interviews with purposively selected SMME owners across diverse sectors captured personal experiences and institutional challenges. Thematic analysis revealed that statutory requirements, collateral constraints, and information asymmetry are key barriers to financial inclusion, while financial literacy, government arrears, and fintech innovations such as mobile banking and peer-to-peer lending offer significant opportunities. The findings highlight inclusion prospects for women, youth, and rural entrepreneurs and directly connect to global and regional development priorities, including SDG1 (no poverty), SDG10 (reduced inequalities), and the African Union's Agenda 2063. This study contributes to the literature on SMME financial inclusion by integrating sustainability, equity, and social justice considerations, offering both theoretical insights and practical recommendations for policy and institutional interventions.

Keywords: financial inclusion, SMMEs, entrepreneurship, access to finance, enterprise growth, Gauteng province

Introduction

Financial inclusion is increasingly recognised as a critical pillar of sustainable economic development, particularly in emerging economies where access to capital determines the establishment, survival, and growth of enterprises. In its broadest sense, financial inclusion refers to the provision of affordable and appropriate financial products and services, such as credit, savings, insurance, and digital financial platforms to individuals and businesses traditionally excluded from formal financial systems. For enterprises, particularly small, medium, and micro enterprises (SMMEs), financial inclusion enables access to working capital and long-term investment financing, thereby strengthening business resilience, innovation, and competitiveness (Ross, 2022; Fatoki, 2024). In the absence of adequate financial inclusion, SMMEs remain trapped in informal, vulnerable, and low-growth cycles, limiting their contribution to national development outcomes.



Problem Statement

In South Africa, SMMEs are widely regarded as key drivers of economic growth, employment creation, innovation, and poverty reduction. They contribute over 41% of national Gross Domestic Product (GDP) and employ approximately 87% of the labour force, highlighting their pivotal role in economic development (OECD, 2022). Gauteng Province, as South Africa's economic hub, hosts a diverse and dynamic SMME ecosystem across retail, manufacturing, services, and technology sectors (Ross, 2022). Despite this economic significance, SMMEs in South Africa exhibit alarmingly high failure rates, with between 70% and 80% of enterprises failing within their first five years of operation (Fatoki, 2024). Limited access to finance remains one of the most critical factors underlying these failures, as many enterprises struggle to secure the working capital and investment funding required for sustainability and expansion.

Financial inclusion is also closely aligned with global development frameworks, particularly Sustainable Development Goals (SDGs) 1 and 10, which emphasise poverty reduction and inequality mitigation through equitable access to financial services. In South Africa, where historical and structural exclusion persists, financial inclusion is not only an economic imperative but also a social justice priority (Fatoki, 2024). Expanding financial access for SMMEs can stimulate enterprise growth, job creation, and inclusive economic development, thereby accelerating progress towards national and global development targets. Despite its importance, SMMEs remain among the most financially excluded economic actors. The South African Reserve Bank reported that approximately 80% of SMMEs face significant challenges in accessing finance, with only 30% of loan applications approved in 2023 (SARB, 2023). Structural barriers including stringent collateral requirements, information asymmetry, limited financial literacy, and regulatory constraints such as the National Credit Act further restricts access to formal financial services (Egu & Chiloane-Tsoka, 2023). Consequently, many SMMEs rely on informal financing mechanisms such as personal savings, family contributions, and trade credit, which are often insufficient and unsustainable in the long term (Asah et al., 2021). Although existing literature has extensively examined financial inclusion among households and individuals, research focusing on SMMEs particularly within South Africa and Gauteng Province remains limited.

Given Gauteng's central role in the national economy, understanding the barriers and opportunities affecting SMME financial inclusion in this region provides critical insights into broader systemic challenges within the financial ecosystem. This study therefore seeks to explore the barriers and opportunities associated with financial inclusion among SMMEs in Gauteng Province, contributing both theoretically and practically to policy and institutional interventions aimed at enhancing inclusive enterprise development.

Literature Review

2.1 Theories of Financial Inclusion

The concept of financial inclusion is grounded in multiple theoretical perspectives that explain why access to finance is central to the survival and growth of SMMEs. One of the dominant frameworks is the Resource-Based Theory (RBT), which posits that firms achieve sustained competitive advantage through valuable, rare, inimitable, and non-substitutable resources



(Barney, 1991). From this perspective, financial capital is viewed as a strategic resource that enables firms to invest in innovation, technology, and human capital. Utami and Alamanos (2022) argue that financial capital, technological capability, and managerial competence are essential for sustaining competitiveness. Similarly, Rungani and Potgieter (2018) observe that many SMMEs fail due to insufficient financial resources, while Neneh et al. (2016) and Adomako and Danso (2014) demonstrate that access to capital enhances growth, performance, and innovation.

However, RBT has been criticised for its limited attention to external institutional constraints, particularly in developing economies where access to resources is shaped by regulatory and structural barriers. In the South African context, SMMEs operate in highly competitive markets where financial resources are unevenly distributed, suggesting that internal resource endowments alone cannot fully explain financial exclusion. This limitation necessitates complementary theoretical lenses that incorporate institutional and market imperfections.

Complementary Lenses Financial Intermediation Theory (CLFIT) provides insight into the role of financial intermediaries in bridging the gap between savers and borrowers by reducing transaction costs and pooling risks. While CLFIT predicts efficient capital allocation through intermediaries, empirical evidence in South Africa reveals a disconnect between theory and practice. Msomi and Olarewaju (2021) argue that financial intermediation should facilitate small business development, yet banks continue to prioritise large and low-risk clients. This contradiction highlights the structural bias within financial systems that perpetuates SMME exclusion, thereby challenging the assumption of neutral intermediation.

Closely related is the Theory of Asymmetric Information (TAI), which explains credit rationing under imperfect information conditions (Stiglitz & Weiss, 1981). Lenders, unable to accurately assess borrower risk, often restrict credit rather than adjust interest rates. Jordaan and Coetzee (2021) show that information asymmetry accounts for a significant proportion of loan rejections in South Africa, while Asah et al. (2021) note that SMMEs are often perceived as inherently volatile. While TAI effectively explains lender behaviour, it tends to underemphasise the role of institutional support mechanisms that could mitigate informational gaps, such as credit bureaus and government-backed guarantees.

The Financial Literacy Framework (FLF) adopts a demand-side perspective, emphasising the role of entrepreneurial capability in accessing finance. Herrington and Kew (2018) and Mahloana (2019) argue that inadequate financial literacy weakens loan applications and business planning capacity, thereby reducing approval probabilities. Appeaning (2019) further suggests that poor financial forecasting undermines lender confidence. Nevertheless, focusing solely on literacy risks overstating individual responsibility while neglecting systemic financial exclusion rooted in institutional and structural constraints.

Institutional Theory (IT) extends the analysis by highlighting the influence of formal rules, norms, and regulatory structures on economic behaviour. North (1990) contends that institutions shape incentives and economic outcomes. In South Africa, regulatory frameworks such as the National Credit Act and Financial Sector Regulation Act aim to protect consumers but inadvertently impose stringent compliance requirements on SMMEs. Egu and Chiloane-Tsoka (2023) demonstrate that regulatory burdens and delayed government payments increase the perception of SMMEs as high-risk borrowers. While IT effectively captures



structural constraints, it is less explicit about how informal institutions and social norms influence access to finance.

Social Capital Theory (SCT) addresses this gap by emphasising networks, trust, and relationships as alternative mechanisms for accessing finance (Putnam, 2000). Ahinful et al. (2021) find that strong networks enhance financing opportunities, while Phillip (2022) shows that networking improves market resilience. However, reliance on social capital may reinforce informal financing systems and limit integration into formal financial institutions, thereby sustaining dualistic financial structures.

Collectively, these theories demonstrate that financial inclusion is a multidimensional phenomenon shaped by internal firm resources, financial intermediation mechanisms, information asymmetry, entrepreneurial capability, institutional structures, and social networks. While each theory offers valuable insights, none alone sufficiently explains SMME financial exclusion, underscoring the need for an integrated theoretical framework.

2.2 Global and African Perspectives on SMME Financing

Globally, SMMEs account for over 90% of businesses and generate approximately 50–60% of employment, making them central to economic development strategies (OECD, 2022). Developed economies offer diverse financing instruments, including venture capital, angel investors, crowdfunding, and credit guarantee schemes, enabling firms to match financing sources to lifecycle stages. Demirgüç-Kunt et al. (2020) argue that diversified financial ecosystems reduce reliance on traditional banking and support innovation. In contrast, developing economies rely heavily on banking institutions that are risk-averse and reluctant to lend to small enterprises. The World Bank (2021) estimates a global SMME financing gap exceeding USD 5.2 trillion annually, with Sub-Saharan Africa accounting for USD 350 billion. Cull and Xu (2021) identify structural constraints such as weak capital markets and inadequate collateral frameworks as key barriers. This structural financing deficit suggests that financial exclusion is not merely a firm-level problem but a systemic market failure. African economies display heterogeneous financing environments. Kenya's mobile money platforms have improved microfinance access, while Nigeria continues to face corruption and weak credit markets. South Africa presents a paradox: despite having one of Africa's most sophisticated financial systems, SMMEs remain financially excluded. The South African Reserve Bank (2023) reports that only one-third of SMME loan applications are approved, reflecting systemic risk aversion. Regulatory frameworks such as the NCA and FSRA, while enhancing transparency, impose stringent lending requirements that disadvantage smaller firms (Egu & Chiloane-Tsoka, 2023; Moodley, 2018). Comparative studies indicate that African SMMEs depend heavily on internal financing, informal savings, and family networks (Asah et al., 2021). While these mechanisms provide short-term survival capital, they constrain scalability and long-term growth. This reliance highlights the persistence of survivalist entrepreneurship rather than transformative enterprise development.

2.3 Barriers to SMME Financing

SMMEs face interconnected barriers that restrict growth and sustainability. Risk aversion among financial institutions remains a primary obstacle, as banks perceive SMMEs as volatile and high-risk (The Banking Association of South Africa, 2021). Information asymmetry exacerbates this perception, leading to credit rationing (Jordaan & Coetzee, 2021). Asah et al. (2021) further show that mismatches between lender requirements and borrower capacity contribute to widespread loan rejections. Regulatory barriers also constrain access to finance.



Although the NCA and FSRA enhance systemic stability, compliance burdens disproportionately affect small enterprises (Egu & Chiloane-Tsoka, 2023; Kato & Chiloane-Tsoka, 2024). Delayed government payments further weaken SMME cash flows, increasing lender risk perceptions (The Banking Association of South Africa, 2021). These findings suggest that regulatory frameworks, while protective, may unintentionally perpetuate financial exclusion. Collateral requirements represent another critical constraint. Herrington and Kew (2018) note that many SMMEs lack tangible assets acceptable to lenders. Mahloana (2019) highlights that informal accounting practices reduce lender confidence, leading to exclusion even for viable enterprises. This underscores a structural mismatch between traditional banking models and SMME asset structures. Demand-side barriers such as financial illiteracy further limit access. Poor financial management skills reduce loan approval probabilities (Herrington & Kew, 2018; Mahloana, 2019; Asah et al., 2021). However, attributing exclusion solely to literacy risks obscuring institutional and systemic failures that constrain access even for financially literate entrepreneurs.

2.4 Opportunities for Enhancing Financial Inclusion

Despite these barriers, emerging opportunities exist. Fintech innovations reduce transaction costs and expand micro-lending opportunities (Allen et al., 2021). Mobile money platforms demonstrate the transformative potential of digital finance for SMMEs. Government programmes, such as credit guarantees and training initiatives, can reduce lender risk perceptions and improve borrower capability (Sophocleous, 2019; Mukherjee, 2021). Development Finance Institutions such as IDC and SEFA provide targeted financing for high-risk sectors, supporting industrialisation and employment creation (Saah & Musvoto, 2020). Inclusive banking initiatives targeting women, youth, and rural enterprises reflect global impact-investing trends, combining financial and social outcomes. Alternative financing mechanisms, including crowdfunding and angel investment, offer additional capital channels, although their adoption remains limited in South Africa (Egu & Chiloane-Tsoka, 2023).

2.5 Position in Sustainability and Equity Discourse

Financial inclusion is integral to sustainability and equity. It aligns with SDGs 1 and 10, addressing poverty and inequality through equitable financial access (United Nations, 2015). Abisuga-Oyekunle et al. (2019) and Taylor and Woodhams (2022) emphasise SMMEs' role in poverty alleviation and inclusive development. Access to finance enhances resilience, enabling enterprises to invest in innovation, diversification, and sustainability initiatives aligned with Agenda 2063 (AU, 2015).

2.6 Synthesis

The literature demonstrates that SMME financial inclusion is shaped by interrelated theoretical, institutional, and practical factors. While developed economies benefit from diversified financing ecosystems, African SMMEs face regulatory constraints, collateral limitations, and low financial literacy. Emerging opportunities in fintech, government programmes, and inclusive banking offer pathways to expand access. Integrating financial inclusion into sustainability and equity frameworks highlights its dual role in economic growth and social justice, underscoring the need for systemic policy and institutional reforms.



Research Design and Methodology

Research Paradigm and Design

This study adopted an interpretivist epistemological paradigm and a qualitative research methodology to explore the challenges and opportunities associated with financial inclusion among SMMEs in Gauteng, South Africa. The objective was to gain in-depth insight into the experiences of SMME owners regarding financial systems, the barriers they encounter, and how they address their financial needs. The study further aimed to contribute to contextualised knowledge on financial inclusion in emerging-market environments and to provide practical insights for policymakers, financial institutions, and support agencies seeking to design more inclusive financial systems. Interpretivist epistemology emphasises constructed and context-dependent meaning (Creswell, 2018; Alharahsheh & Pius, 2020). This paradigm was considered appropriate for capturing how entrepreneurs perceive and experience financial inclusion within the complex socio-economic context of Gauteng.

Research Approach

A qualitative exploratory research design was employed to document and interpret participants' lived experiences (Flick, 2018).

Research Method

Semi-structured interviews with probing questions enabled participants to openly share their experiences. Interviews were conceptualised as interactive dialogues that co-produce knowledge between researcher and participant (Easwaramoorthy, 2016; Melnikova, 2019). Questions addressed legal compliance, collateral requirements, and financial literacy challenges across different business contexts.

Population and Sample

Purposive sampling was used to select SMME owners from diverse industries, including manufacturing, construction, human resources, and financial services (Creswell, 2018). Selection criteria included ownership of an SMME, willingness to participate, and experience seeking financial capital. Four participants were recruited.

Population and Sample

Data were collected through virtual interviews conducted in August 2024 via Microsoft Teams. The interview guide covered (a) business and owner background, (b) statutory compliance, and (c) barriers and facilitators to financial capital access. Interviews lasted 45–60 minutes, were recorded with consent, transcribed verbatim, and analysed. Ethical clearance was obtained from the relevant university, and informed consent, anonymity, confidentiality, and secure data storage were ensured.

Research Instrument

Thematic analysis followed Braun and Clarke's (2006) six-step framework. Atlas.ti software was used for coding and theme development, with themes such as statutory requirements, collateral constraints, and alternative funding emerging from participant accounts. Trustworthiness was ensured through credibility, dependability, transferability, and confirmability (Lincoln & Guba, 1985). Credibility was enhanced through triangulation and member checking. Dependability was supported by maintaining an audit trail of coding and analysis. Thick descriptions were provided to support transferability, while reflexivity and systematic documentation of interpretive decisions ensured confirmability.



Ethical Considerations

The present study has been conducted following high ethical principles in the process of designing and executing the study. The reason behind the research, voluntary participation and rights to drop out of the research at any cost was fully informed to all subjects at the beginning of the study. An informed consent was obtained before the commencement of interviews. Alienation of names and business identification of the participants would preserve confidential information and anonymity, which was left out in the transcript, and findings. Data gathered were safely kept among the password-protected files that were only accessible to the researcher and will be destroyed after the stipulated retention period. The study was ethically cleared per the research ethics regulation at the university and thus, the research done conformed to what is accorded by the university and professionally is acceptable.

Results and Findings

This section presents the empirical results of the research study which is divided into five thematic areas which emerged from the semi-structured interviews: (1) financial environment of SMMEs, (2) statutory compliance, (3) access to financing modalities, (4) exclusionary barriers, and (5) the use of entrepreneurial strategies. The results are discussed in relation to relevant literature and developmental alternatives to date - most prominently with the United Nations Sustainable Development Goals (SDGs) and the Agenda 2063 provided by the African Union in mind.

4.1 Financial Background of SMMEs

The backgrounds of the SMMEs that had been involved in the project were of a substantial range and several trends were noticed (see Table 1). The four participants revealed that they had previously recorded turnovers of nearly or even exceeding R10million within their businesses. The overall level of turnover was relatively high but three of out of the four businesses did not have professional financial personnel. They rather used the experience of their owners or hired an accountant service. The participant who possessed a B-Tech degree in the field of finance stated that they were able to handle the day-to-day financial tasks of the business, whereas the other participants acknowledged that they found difficulty in the record keeping and long-term planning. Such information illustrates the role that individual capacity plays in financial management, as well as exposes differences in the way entrepreneurs prepare their businesses to access formal finance systems.

Table 1: Financial background of participating SMMEs

Participant	Education Level	Sector	Turnover	Financial Team	Self-reported Competence
1	B-Tech Engineering	Manufacturing	R10m+	None	Relies on technical expertise
2	B-Tech Finance	Construction	R10m+	None	Confident in financial management
3	MBA	HR Recruitment	R10m+	None	Outsources financial services



4	MBA	Financial Services	R10m+	Yes	Strategic oversight

Source: Fieldwork interviews (2025)

Table 1 provides some but not conclusive information on the financial management capacity of the involved SMMEs. Although the table does not provide much information about the biography of the persons and the organisation, the overall trend is the same: even though the turnover rates are rather high, in three out of four businesses, there are no dedicated financial staff members, and the owner knowledge is used instead or the outsourced accounting services. Such a trend follows the literature that the lack of formal financial management framework can limit the access to external finance (Fatoki, 2020; Neneh, 2019). Extremely, there should be no over-interpretation of the data, but the set of self-reported problems with record-keeping and the absence of internal financial knowledge indicates that education alone is not a complete mitigating factor regarding institutional impediments to funding. Instead, reinforced financial management and internal controls are also crucial predictors of financial credibility and long-term viability alongside already found evidence that demonstrate that financial literacy and governance capacity are major drivers of SMME finance preparedness.

4.2 Statutory Requirements and Compliance

The theme of statutory compliance was also a repetitive theme in the reflections of the participants especially as far as business registration with the Companies and Intellectual Property Commission (CIPC), tax compliance and maintenance of accurate financial record is concerned. Respondents pointed out that fulfilment of such requirements was not only a legal issue, but also a critical tool of gaining credibility with the formal financial institutions. As one participant explained,

“If your paperwork and taxes are in order, banks and government funders take you seriously. It opens doors.”

Another participant highlighted the reputational significance of compliance, noting that

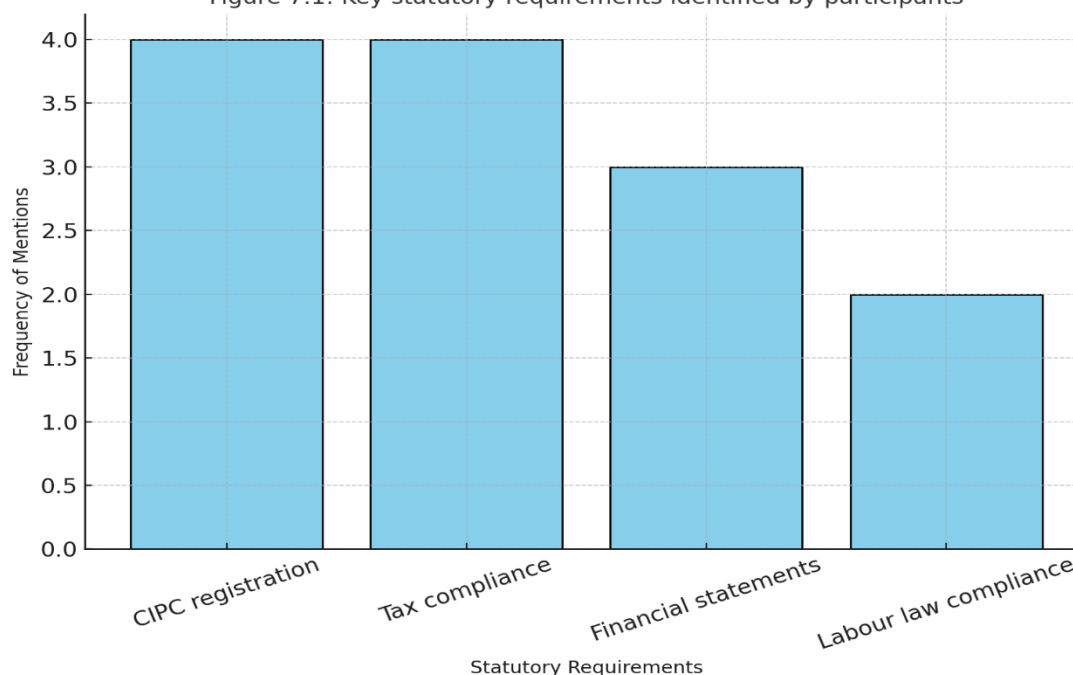
“without proper registration and tax clearance, you are already blocked before you even apply for funding.”

These observations imply that even the satisfaction of statutory criteria is seen as a precondition to the utilization of official finance and government assistance, despite the administrative and financial overheads of keeping the compliance levels complete.

Figure 1 Key statutory requirements identified by participants



Figure 7.1: Key statutory requirements identified by participants



(Source: Fieldwork interviews, 2025)

The findings of the research support optimistic findings of Fatoki (2020), who argues that legal adherence is one of the fundamental but critical obstacles preventing SMMEs in accessing external funds. Chimucheka and Adebisi (2020) also argue that compliant payments in the form of taxes represent fiscal discipline and, as a result, improve the reliability way of thinking by financiers. However, the compliance subjects were found to have some downsides by participants, such as the high financial costs of keeping accounting records and the increased administrative labour that is needed to file the tax returns. The findings depict that there is always tension in between the regulatory goals and the real on-the-job situations of small businesses.

It is worth mentioning that none of the participants mentioned the National Credit Act (NCA) or the Financial Sector Regulation Act (FSRA), although they have become the recent important influencers of financial context. This commission might be indicative of the fact that there is a low level of knowledge regarding macro-level regulation, and entrepreneurs enact themselves into enforcement mandates, and not the macro-level policy construct. This observation is supported by relevant literature. For instance, Egu and Chiloane-Tsoka (2023) assume that even though the NCA was designed to restrain reckless lending, the extensive requirements intent to disadvantage small businesses.

The area of statutory compliance appears to be consistent with current purposes of global development. Compliance strengthens integrity of financial systems through transparency and accountability to establish a trust between lenders and borrowers which is a desired goal in respect to SDG 16 (Peace, Justice, and Strong Institutions). In the South African Agenda 2063, clear and responsible business measures are proposed to ensure the culture of ethical and sustainable economies. In turn, the results of the study confirm that despite the inability to



access the finance without compliance, it also creates exclusionary processes, and it is necessary to change the policy so that not to overload small businesses unnecessarily.

4.3 Access to Financing Forms

Participants noted that they have used a combination of financing sources to start and run their business. Formal bank loans were also reported to be difficult to access as they require collateral and subjective credit appraisal which forces most of the entrepreneur to access personal savings, supplier credit, and government support schemes. In line with the literature on African SMME finance ecosystems, the funding channels of participants are a combination of both the formal and informal process that is influenced by the perceived risk, institutional constraints, and the presence of other finance. The summary of the key sources of finance available to participants and their features is summarised in Table 2

Table 2 Primary Financing Sources Accessed by Participants

Financing Type	Frequency of Use	Key Observations
Commercial bank loans	1	Difficult to secure, high collateral demands
Government grants (GEP, DTI)	2	Support tied to compliance with statutory requirements
Developmental Finance Institutions (IDC, SEFA)	1	Provided support for risky sectors
Personal savings	3	Most common and immediate source
Supplier credit	2	Short-term but limited scalability

Source: Fieldwork interviews (2025)

The results indicated by Table 8.2 are also validated by research from Ngonisa *et al.* (2023), who argue that financing gap is a major factor of SMME failure, and a significant percentage of companies stop their activities within the first five years of their operations. Ahinful *et al.* (2021) also note that the companies that survived this hopeless stage have a greater opportunity to attract formal capital, as they are estimated by lenders as less risky organizations. In addition, Phillip (2022) stresses that growth-oriented SMMEs require diversified funding avenues to enable expansion of its operations, which is repeatedly explored by participants whose existence depends on the mixed source of funds.

Interviews data also indicated trends present in the rest of Africa. In many environments, entrepreneurs belong to the category of being dependent on personal savings and informal processes caused by a limited access to formal credit (World Bank, 2021). Inasmuch as partially the covered grants and Development Finance Institutions (DFIs) provide alleviation, it falls short in the demand. This observation corresponds with that of Saah and Musvoto (2020), who believe that developmental finance should upscale in order to promote industrialisation goals.

This finding also seems relevant to the Sustainable Development Goal of 1 (No Poverty), which recognizes improved access to finance as the ability to grow and maintain jobs and business, which could have a direct effect to reducing poverty. In the same way, the increased



access to underserved populations supports SDG 10 (Reduced Inequalities) because financial exclusion disjoins women, the younger generation, and rural entrepreneurs disproportionately. Through Agenda 2063, there is recognition of the fact that diversified financing is inalienable in development of inclusive economies. Altogether, the results reaffirm current sources that outline the inadequacy of bank-monopolized regimes and emphasize the need of the policy interventions to expand the alternative financing opportunities, such as fintech and impact investment.

4.4 Barriers to Inclusion

The participants identified various financial limitations that limited their access to official funds. Major barriers were the lack of adequate collateral, asymmetry of information and government payments. Fixed assets were owned by a small number of people, so the participants were often unable to collateralize or get collateral requirements and face loan rejections. As one participant stated,

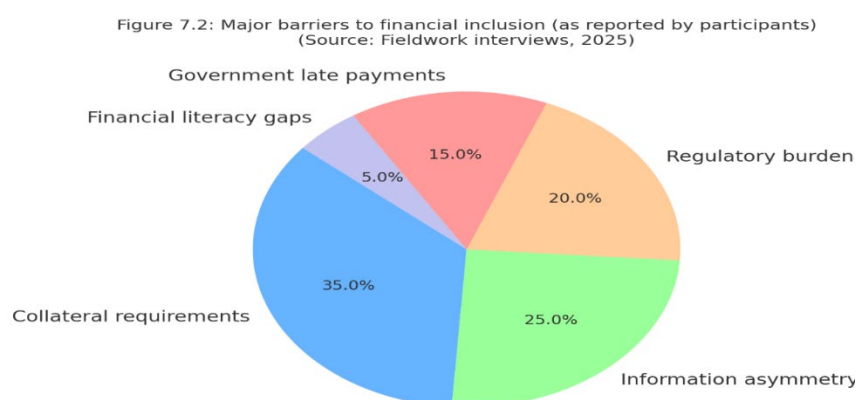
“The bank asked for property or big assets, but as a small business you simply don’t have that so the door closes immediately.”

Another recurring concern related to billing and payment cycles, particularly with public-sector clients. One respondent explained,

“When government pays late, it damages your cash flow and even your credit record, but there's nothing you can do meanwhile, penalties just pile up.”

Participants were also found to point out that informal accounting systems although common with resource-constrained settings, tended to compromise their perceived credibility in the eyes of lenders. The results are consistent with Figure 7.2 that shows the major obstacles to financial inclusion faced by the interviewees.

Figure 2: Major barriers to financial inclusion (as reported by participants)



(Source: Fieldwork interviews, 2025)



The current research supports the available literature that identifies collateral as one of the key obstacles (Herrington and Kew, 2018). Jordaan and Coetzee (2021) believe that such information asymmetry also enhances exclusion, as lenders cannot assess the risk profile of small firms holistically. Although the regulatory requirements that are part of National Credit Authority (NCA) and Financial Sector Regulatory Authority (FSRA) are well-explained, they worsen the situation (Kato & Chiloane-Tsoka, 2024). Cash-flow dynamics have been also reported by the Bank of South Africa (2021) to be distorted by the government-related late payments and have also destroyed credit-worthiness.

The lack of financial literacy, with little mentions carried out by participants, still has severe impact. Mahloana (2019) has found that entrepreneurs are likely to include unpersuasive bank loan applications in case of their insufficient literacy skills, and Asah *et al.* (2021) state that requiring literacy is at the heart of using alternative financing systems successfully. The noted discrepancy in the focus of participants and scholars assumes that, in spite of the fact that literacy is pivotal indeed, entrepreneurs do not see financial literacy as a key challenge, devoting their attention rather to structural barriers like collateral.

Once there are larger development systems in which these stands create exclusionary processes, then the Sustainable Development Goal State 1 on growth hinders the ability of businesses to grow and produce new jobs. In addition, they support systemic inequality, which violates Sustainable Development Goal 10. They present obstacles to inclusive finance, which destroys the creation of balanced and sound-faith economic systems in Agenda 2063.

As a result, the present study confirms the current body of research on the long-term sustainability of collateralizing and the information asymmetry, but also adds to the discussion due to predictive late payments imposed by the governments as a structural issue that warrants immediate changes.

4. 5 Strategies Used by Entrepreneurs

Although the structural barriers as mentioned above exist, there was resilience and agency in the pursuit of financial inclusion among the participants. One of the main strategies was to build and nurture good ties with the financial institutions, suppliers and other businesspersons. Networking became a significant strategy, and one of the players described it as follows,

“You cannot wait for funding to find you — I attend business events, talk to bank managers, and keep in touch. It helps when they know your face and your business.”

Another participant emphasised the importance of diversifying financing pathways beyond traditional bank loans, noting,

“Instead of wasting time with banks that keep rejecting us, we applied for grants and SEFA funding — and that actually worked.”

Other ones used supplier credit and professional upskilling to enhance their financial records and compliance abilities. These tactics depict how financial institutions respond to constraining lending conditions in the form of Table 3 and confirm the essential nature of proactive behaviour in promoting financial inclusion in resource-restricted settings.

Table 3: Strategies used by participants to improve financial inclusion



Strategy	Description	Impact
Networking with financiers	Attending events, maintaining contact	Increased credibility and opportunities
Leveraging grants/DFI funding	Applying for GEP, IDC, SEFA support	Improved compliance and growth prospects
Supplier relationships	Using trade credit to sustain operations	Provided short-term liquidity
Personal capacity building	Upskilling in finance and compliance	Enhanced ability to meet lender requirements

Source: Fieldwork interviews (2025)

The focus by study participants on networks aligns with results offered by Shane and Cable (2018), who believe that social capital improves the credibility of organisations and helps to obtain financial resources. Phillip (2022) concurs that market intelligence and organisational resilience are clear benefits of networking. The characteristic of participant's employment of grants and development finance institutions (DFIs) is consistent with evidence shared by Mukherjee (2021), who highlights the critical role played by the government programmes in overcoming financing gaps.

Sustainability wise, such strategies drive organisational resilience through the ability of the concerned entrepreneurs to adjust to schismatic market forces at the same time they retain their operations continuum intact. The resilience measures put in place because of Sustainable Development Goal (SDG) 1 enable the preservation of employment and income. In the case of SDG 10, the unnecessary use of alternative forms of financing limits inequalities through wider access to marginalised populations. Agenda 2063 also highlights innovation and resilience as the essentials of attaining inclusive growth.

5 Synthesis of Findings

Summatively, findings from the present study reveal a paradox, namely that SMMEs in Gauteng seem to have high potential as indicated by the high turnover rates and entrepreneurial resistance, but is limited in growth by structural and institutional barriers. The study's empirical findings support relevant literature on the primacy of collateral, information asymmetry and regulatory constraints for SMMEs. It thus moves enhanced the scholarly debate, highlighting late governmental payments as an immediate but not sufficiently investigated hurdle.

In terms of development frameworks, evidence from the present study is consistent with goals 1 and 10 of the Sustainable Development Goals emphasising that poverty cannot be alleviated and inequality is mitigated without financial inclusion of people. In a similar vein, the results are consistent with Agenda 2063, which focuses on inclusive, innovative and sustainable development. However, multiple barriers seem to complicate the attainment of those global and continental aspirations.

The findings of the study suggest, as far as policy implications go, that policies reform is needed in terms of reducing compliance burdens, providing increased alternative finance, and ensuring that government payments are made swiftly. The need for promoting financial literacy and professionalism in SMME management also seem clear.



Managerial Implications

Concurrently, the analysis has also presented some possibilities of improving financial inclusion. For instance, mobile banking and peer-to-peer lending websites are fintech modifications spreading around South Africa providing alternative trade options that lower the expenses based on transactions and enhance transparency. Minor reprieve is achieved by government programmes, such as grants and low-interest loans via lending organisations such as the Gauteng Enterprise Propeller, which de-risks lending to the small firms. Sector-focused assistance, particularly that of Development Finance Institutions (DFIs) like the Industrial Development corporation (IDC) or the Small Enterprise Finance Agency (SEFA), has also not received much attention by commercial banks. Also, women, youth- and rural entrepreneur-oriented aspects of inclusive banking are growing, and more opportunities are emerging through crowdfunding and angel investment groups, although they are not yet adequately developed.

Conclusions and Future Research

The purpose of the present study was to determine the opportunities and challenges associated with financial inclusion of SMMEs in the Gauteng province in order to better understand the implications of financial access on the survival and growth of SMMEs. Based on interview data and literature review evidence, the study has indicated that while SMMEs have an important role to play in the economy, they are still systematically excluded from legitimate financial markets. The evidence points at new trajectories to enhance and support financial inclusion, not only in South Africa, but also across the continent.

6.1 Summary of Strengths and Weaknesses

A variety of obstacles inhibiting access to finance for SMMEs were foregrounded by the present study. Such obstacles include too many statutory requirements, compliance burdens, collateral requirements, information asymmetry and low levels of financial literacy. Collateral is a particularly challenging aspect in that small business owners simply do not possess the strong assets that banks considered necessary for collateral, coupled with cash flow and financial position being negatively affected by late payments from government agencies. However, a form of credit rationing is based on information asymmetry between lenders and small firms so that the entrepreneur is unable to provide audited records or financial statements as required by the financial institution.

6.2 Financial Inclusion as the Brand Strength

The results of the present study confirm that financial inclusion is not a technical necessity but a geographical growth facilitator to SMMEs. Companies that have access to sound finance are likely to invest in new projects, to develop new markets and to maintain their level of employment. Thus, financial capital stands out as one of the key resources that both competitiveness and resilience depend upon. For example, inclusive finance schemes could turn survivalist businesses into businesses with growth potential and which can assist in achieving the national goals of poverty alleviation and jobs created in the Gauteng economic region of South Africa. These two goals fit well within the United Nations sustainable development goals (SDG 1: No Poverty, SDG 10: Reduced Inequalities). The African Union Agenda 2063 was built on the argument for having inclusive, sustainable and innovative economies. Financial to unlock the potential of SMMEs to contribute to the economic and



social goals would then occur when financial capital is placed within a more integrated developmental framework.

6.3 Implications

From the study results a number of implications are pointed out that could enhance and promote the financial inclusion of SMMEs:

i. Enhance Financial Literacy

Special financial literacy courses are to be prioritised to familiarise entrepreneurs with financial management, credit facilities and relevant regulations. These programmes are deliverable with the cooperation of the banks, universities and government agencies. Improved financial literacy can assist SMMEs to present well-written business plans, to operate cash flows and to better interact with financiers.

ii. Form collaborations with Various Financial Intermediaries

Relevant policy-makers need to promote closer liaisons between SMMEs and a diverse range of financial institutions such as DFIs, commercial banks and fintech firms. Trust-based differences can be overcome by frequent contact platforms, networking and industry alliances which will provide entrepreneurs with chances to receive custom financial solutions.

ii. Promote Fintech Adoption

Affordable and accessible digital financial solutions need to be promoted. Cost-effective alternatives to conventional lending are promotable by the use of policies that support mobile banking, digital wallet and blockchain-based financing, especially among the underbanked sectors.

Iv Reforms in Policies to Reduce Compliance Costs

The regulatory measures like the Financial Sector regulation act and the National credit act needs revising so that consumer protection is not compromised but also that small businesses are not unduly sidelined. The bureaucratic challenges of monitoring compliance and capacity-building policies would be alleviated by the establishment of simplified compliance and capacity-building policies to facilitate the creditworthiness of SMMEs. It is also essential to follow the government policy on timely payments to suppliers to alleviate cash-flow concerns for small businesses.

Vi Investment in Sustainable African Development

Once barriers to financial inclusion have been removed and opportunities unlocked, the basis for financial inclusion as a driver of sustainable development in Africa can be established. By strengthening the financial ecosystem of SMMEs, job creation and poverty alleviation in South Africa can be addressed, and industrialisation and innovation stimulated. From a continental perspective, the proposed approaches align with the vision of Agenda 2063 which speaks of inclusive structural economic transformation and long-term sustainable development. Financial inclusion is thus a developmental mandate not only limited to business success; it is part of the bigger picture of social welfare.



Conclusion

The present study contributes by indicating that while structural and institutional constraints within the finance landscape that affect SMME growth exist, SMMEs within Gauteng are still resilient and have entrepreneurial business capability. Such a position implies much potential for improvement. However, a transformed funding environment is needed, using fintech, other forms of government assistance, and new arrangements for financing SMMEs. Relevant policymakers, financiers and entrepreneurs should work together to close the identified gaps making financial inclusion be one of the motivators of economic competitiveness as well as social equity. By integrating finance inclusion with poverty removal strategies and inequality, the South African SMME sector will be empowered and provide gains for Africa it's long-term outlook on supporting sustainable and inclusive development.



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Modernizing Ancestrality? Integration Between Tradition and Innovation In Amazonian Communities Through Organizational Alliances

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Abstract

The Amazon is a territory that brings together diverse communities and traditional peoples (CTPs), whose political organizations are shaped by identities grounded in their own knowledge systems. The Amazon has been a site of dispute and economic exploitation of regional sociobiodiversity inputs, which supply value chains and compose innovative products in sectors such as pharmaceuticals, cosmetics, and food. This relationship between tradition and innovation results not only in economic impacts, but also in social and environmental ones.

The effective participation of communities in production chains is vital to strengthening these chains in the region. This insertion, however, is accompanied by market requirements aimed at competitiveness and sustainable development, fostering the need for innovation on multiple fronts within communities. The objective of this article is to identify types of innovation (technological—products and processes; managerial; and transactional) developed by traditional community businesses through alliances, and to analyze how these innovations are integrated with indigenous/traditional knowledge.

Keywords: Communities And Traditional Peoples; Innovation; Alliance; Indigenous/Traditional Knowledge.

Introduction

Background

The Amazon is a territory that brings together diverse communities and traditional peoples (CTPs), whose presence has been studied from multiple perspectives, including cultural aspects, social ways of life, the construction of collective identities, and specific territorialities. Their political organizations are marked by identities grounded in sociocultural values and the historical dynamics of the region, embodying principles, autonomy, and their own knowledge systems. At the foundation of these systems lies knowledge inherited from indigenous populations that have inhabited the region since before European colonization in the sixteenth century (OLIVEIRA; SILVA, 2019; FARIAS, 2007; TRECCANI, 2006; MORÁN, 1990). The knowledge of these traditional peoples originates from collective understandings associated



with biodiversity; it is millennia old, passed down through generations, and embedded in customs and traditions (MAGNI; PEGORARO; CUSTÓDIO, 2020). Thus, Amazonian biodiversity is also a sociocultural construction, not merely a natural outcome, validating the concept of “sociobiodiversity” (DIEGUES, 1999).

On the other hand, especially over recent decades, the Amazon has been a site of dispute and economic exploitation of regional sociobiodiversity inputs that supply production chains and compose innovative products in sectors such as pharmaceuticals, cosmetics, and food (DIAS; GALINA, 2025). This relationship between tradition and innovation produces not only economic, but also social and environmental impacts. The value of these communities for preserving tangible and intangible heritage through the use of indigenous knowledge in environmentally sustainable production practices (environmental preservation), social preservation (cultural continuity), and territorial protection is undeniable (LEVIS et al., 2024).

To realize the opportunities of Amazonian sociobiodiversity, the effective participation of communities in production chains is vital to strengthening these chains in the region (LIMA et al., 2024). This assertion, however, is accompanied by market requirements aimed at competitiveness and sustainable development, fostering the need for innovation on multiple fronts within communities. Despite the great economic potential of these chains, community enterprises are still at an early stage of business development (LIMA et al., 2024; SANTOS; LIBONI, 2020). Thus, CTPs are recognized for their traditional knowledge related to the Amazon, which represents a major value asset, yet the challenge lies in using this knowledge to develop businesses that align economic interests with potential social and environmental impacts.

Engaging different actors to address environmental and social challenges is a current trend (KRASNIQI; JONGE, 2022) and is expected for achieving the United Nations Sustainable Development Goals (SDGs), such as Goal 11.4: “Strengthen efforts to protect and safeguard the world’s cultural and natural heritage.” Accordingly, over the years, the pursuit of sustainable development has led to an increase in partnerships formed among different organizations—companies, research institutes, universities, and CTPs (SANTOS, 2019).

However, safeguarding and valuing traditional knowledge is not straightforward. Although international norms and agreements, such as the United Nations Declaration on the Rights of Indigenous Peoples, advocate the protection of indigenous rights and knowledge, the implementation of practical actions for their preservation still lacks in-depth study. Moreover, there remains a gap in understanding how to support communities in employing and adapting this knowledge in their daily lives, indicating the need for further actions in traditional knowledge management and, consequently, community strengthening (TANG; GAVIN, 2016). Thus, partnership initiatives involving CTPs seek to enhance value creation derived from indigenous knowledge based on observations and experiences accumulated over time—knowledge that is significant for sustainable environmental management (GADGIL et al., 1993).

Within this context, the objective of this article is to identify types of innovation (technological—products and processes; managerial; and transactional) developed by traditional community businesses through alliances, and to examine how these innovations integrate with indigenous/traditional knowledge

Problem Statement

The problem addressed in this study lies in the lack of empirical understanding of how innovations generated through organizational alliances in the Amazonian context integrate with, alter, or challenge traditional knowledge within community-based businesses.



Traditional knowledge has increasingly been valued by partner companies due to its potential to optimize costs and time in research and development for new products (FERREIRA, 1998; REZENDE, 2002; LIMA, 2012). Knowledge sharing fosters innovation across multiple areas (BETHEL et al., 2022) and can help organizations adapt to dynamic environments, contributing to resilience and improved economic conditions by enabling faster responses to market changes (DAVIDSON-HUNT et al., 2012). It has emerged as an essential resource for innovation generation, including the identification of new plant species or the suggestion of possible pharmacological activities through which the innovative process unfolds (FERREIRA, 1998; REZENDE, 2002; LIMA, 2012). Many of these alliances originated from organizational interest in engaging communities to meet demands for new products with sustainable values and supply chain provisioning (CHAVES; GALINA, 2024).

To meet the quality and scale standards required by large companies, communities face an urgent need to innovate and adapt their practices and structures. Innovation thus becomes a fundamental element in strengthening community entrepreneurship, enabling the creation of new products, services, and processes that meet community needs while being socially and ecologically sound (MORHY; COSTA, 2023). Innovation may occur both in the products and services offered by indigenous entrepreneurs and in the ways businesses are organized and managed (MORHY; COSTA, 2023).

In this sense, innovation is a means through which communities can sustain or improve production practices, capital goods, livelihoods, and resilience (DOUTHWAITE et al., 2009). The concept of innovation is broad, commonly associated with new products and production processes, but also encompassing new managerial and transactional models (POLDER et al., 2010). Community businesses face increasing difficulty in dynamic, complex, and uncertain markets, which demands innovative methods (ESPADA; SOBRINHO, 2014) related to functions such as product and process technology, management, and market access (OECD, 2005).

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Within this context, the objective of this article is to identify types of innovation (technological—products and processes; managerial; and transactional) developed by traditional community businesses through alliances, and to examine how these innovations integrate with indigenous/traditional knowledge.

Literature Review

This study adopts the definition of innovation based on three dimensions: technological innovation (product and process), managerial innovation, and market/transactional innovation (OECD). Technological innovation refers to the introduction of a new product and/or significant improvements to existing products, including changes in characteristics, intended use, components, and materials, aimed at better meeting customer needs. Process (operational) innovation refers to significant improvements in production and logistics methods or support activities such as purchasing, maintenance, and accounting. Managerial innovation involves new ways of organizing routine activities to enhance business efficiency (POLDER, 2010), resulting in reduced transaction and administrative costs (KARABULUT, 2015). Transactional innovation includes the use of new distribution channels and new approaches to selling new or existing products. According to Walker (2004), these innovation types influence one another



and should be implemented jointly. These concepts are applicable to the realities of traditional community businesses.

Community businesses face uncertain, dynamic, and complex decision-making environments (FISHER et al., 2000). While they maintain a unique relationship with nature, grounded in sociobiodiversity knowledge that must be preserved and valued, they also require competitiveness to operate in markets. In this regard, innovations provide multiple benefits, helping communities respond to tensions and seize opportunities such as new technologies or artifacts (e.g., machinery, seeds, databases), fostering adaptive resource collaboration based on indigenous values, worldviews, and knowledge, while accounting for social, cultural, and ecological factors (ATHAYDE, 2017).

The integration of traditional or indigenous knowledge with Western science, policy, and management practices has been considered worldwide (HARMSWORTH; POULIOS, 2014). Indigenous knowledge integrated with other forms of knowledge helps promote sustainable innovation at socioecological system levels (DAVIES, 2013; MORISHIGE, 2018), given broad recognition of its foundational role in environmental management, sustainability, and biodiversity conservation (PRETTY et al., 2009).

Collaborations with traditional communities enable the identification, assimilation, and exploitation of indigenous knowledge, benefiting partners such as universities, organizations, government agencies, the private sector, and NGOs, and allowing effective socioenvironmental expansion and innovative improvements (MASON, 2012; DENG; LU, 2021; STACEY, 2015). This relationship can be grounded in the Resource-Based View (RBV), which posits that access to strategic resources drives competitive advantage (BARNEY, 1991). Environmental resource management is thus critical for innovations generated through partnerships with communities holding indigenous knowledge, as such knowledge offers solutions that are economical, ecological, and sustainable (ONWUEGBUZIE; UGWU ANTI, 2016). Traditional communities are essential sources of specific information, support decision-making and natural resource management, and enhance environmental health understanding, offering key perspectives for sustainability in socioecological systems (SULTANA et al., 2019).

Institutional support for innovation linked to multi-stakeholder collaboration with traditional communities promotes development across various domains, complementing Western management science practices for environmental and social improvement (CARLISLE et al., 2013). Strong linkages between holders of indigenous knowledge and scientists are increasingly necessary to explore knowledge integration and resource exchange (SUBBA, 2014). Modern science increasingly recognizes the value of traditional knowledge in applied research and participatory mapping approaches (BETHEL et al., 2022). When conducted ethically and fairly, partnerships result in numerous innovations (ATHAYDE, 2017).

Research Design and Methodology

This study is exploratory and qualitative in design, conducted in two stages. The first involved group interviews, individual interviews, and observations of community-based businesses operated by traditional peoples. Associations and cooperatives of self-identified quilombola, riverine, and/or extractivist peoples were studied to analyze contexts, enterprises, and how alliances contribute to technological, process, managerial, and transactional innovation. The second stage comprised in-depth interviews with key alliance partners identified in the first stage to triangulate and enhance analytical robustness. The project was approved by a research ethics committee.

Data collection for Stage 1 began with a community that had maintained partnerships with companies for at least two decades. Through its partners and supplementary searches, five additional communities were identified using a snowball method. Inclusion criteria were: (i) well-established commercial organizations; (ii) partnerships with relevant Amazonian



institutions; and (iii) application of traditional knowledge in production processes. The final sample comprised six CTP businesses (three cooperatives and three associations). Partners nominated by the communities were also included.

Primary data were collected through group interviews, individual interviews, and observations with leaders and members, as well as individual interviews with strategic partners. The study involved 19 hours of observation, 13 interviews with community businesses, and 22 interviews with 11 partners, totaling 52 interview hours. Data were transcribed using RESHAPE and TRANSCRIPTOR applications and analyzed with ATLAS.ti and Excel. Qualitative content analysis focused on strategic alliances, alliance-driven innovation, and integration with indigenous/traditional knowledge.

Research Paradigm and Design

This study is grounded in an interpretivist research paradigm, which assumes that social reality is socially constructed and best understood through the meanings and interpretations actors attribute within their specific contexts. This paradigm is particularly appropriate for investigating traditional communities, as it allows for an in-depth understanding of indigenous and traditional knowledge systems, social relations, and organizational practices embedded in cultural and historical contexts.

The research design is exploratory, as the study seeks to investigate a phenomenon that remains underexplored in the literature: the development of innovation in traditional community businesses through organizational alliances and its integration with indigenous/traditional knowledge. An exploratory design is justified given the complexity of the phenomenon and the limited empirical evidence available, especially in the context of the Amazon.

Research Approach

The study adopts a qualitative research approach. This approach is appropriate because the objective is not to measure variables or test hypotheses, but rather to understand processes, perceptions, interactions, and meanings related to innovation, alliances, and traditional knowledge within community-based businesses.

Qualitative research enables the exploration of how innovations emerge, how alliances are structured and experienced by different actors, and how traditional knowledge is integrated, transformed, or replaced throughout these processes. This approach is particularly suitable for capturing the socio-cultural and institutional nuances present in traditional communities.

Research Method

According to the research problem approach, this study is classified as exploratory and qualitative, conducted in two stages: the first through group interviews, individual interviews, and observations with community-based businesses of traditional peoples. For this research, associations and cooperatives of self-identified Quilombola and/or riverside (*ribeirinhos*) and/or extractivist peoples were studied to analyze their contexts, their enterprises, and how alliances with other organizations contribute to the development of technological, process, management, and transaction innovation. The second stage consisted of in-depth interviews with the main alliance partners, identified by the members of the associations and cooperatives during the first phase of data collection for triangulation and greater robustness of the analysis. The project was duly approved by a research ethics committee.



Population and Sample

The population of the study comprises community-based businesses of traditional peoples (CBTPs) located in the Brazilian Amazon, including associations and cooperatives of self-identified quilombola, riverine, and extractivist communities.

The sampling technique adopted was purposive sampling, combined with the snowball method. Initially, one community business with partnerships established for over two decades was selected. From this starting point, additional communities were identified through referrals from partners, as well as complementary searches on websites and social media.

The inclusion criteria for selecting community businesses were: (i) being a commercially established and competitive organization; (ii) having formal partnerships with relevant institutions operating in the Amazon; and (iii) applying traditional knowledge in productive activities such as agriculture, extractivism, or agroforestry.

The final sample consisted of six community-based businesses, of which three are cooperatives and three are associations, as well as strategic partners indicated by the communities themselves, including private companies, governmental institutions, NGOs, and universities.



BUSINESS CHARACTERISTICS	COOPERATIVES		ASSOCIATIONS			
	COOPERATIVE 1	COOPERATIVE 2	ASSOCIATION 1	ASSOCIATION 2	ASSOCIATION 3	ASSOCIATION 4
BUSINESS	Cooperative	Cooperative	Association	Association	Association	Association
TCPs	Ribeirinhos + Quilombolas	Ribeirinhos people	Ribeirinhos people	Ribeirinhos people	Ribeirinhos people	Ribeirinhos people
YEAR OF CREATION	Association (1992) / Cooperative (2002)	2010	2002	2003	2004	2002
N° MEMBERS	80	54	75	51	20	134
MAIN ACTIVITY	Extractivism	Extractivism	Agriculture	Agriculture and Extractivism	Extractivism	Agriculture and Extractivism
PRODUCTION CHAIN INTERNSHIP	Oil, butter, and pulp production	Processing of raw material (Almond)	Supply of raw materials and oil production (in the future)	Supply of raw materials	Supply of raw materials	Supply of raw materials and finished products
PRODUCTS SOLD	BUTTER: Cupuaçu seed, Murumuru, Tucumã, Ucuuba / OIL: Andiroba, Patauá, Tucumã, Buriti, Seville / FRUIT PULP:	Tucuma, Murumuru, Andiroba (Almonds)	Pataqueira, Estoraque, Priprioca and Capitui	Pataqueira, Estoraque, Priprioca and Capitui	Andiroba and Murumuru	Priprioca, jams, honey, biojewels, shirts, recycled paper



	Mango, Acerola, Pineapple , Acai					
N° ONE-TIME PARTNERSH IPS	7	7	2	2	0	10
CUSTOMER S NO.	7 (Including multination al cosmetics company)	1 (multination al cosmetics company)	4 (multinatio nal cosmetic s company)	1 multinational cosmetics company)	1 (multinatio nal cosmetic s company)	1 (multinati onal cosmetics company) + B2C direct store sales

Authors (2025)

Research Instrument

Data were collected using semi-structured interview guides, group interview protocols, and non-participant observation scripts. The semi-structured format allowed flexibility to explore emerging themes while ensuring consistency across interviews.

Different interview guides were developed for:
(i) leaders and members of community businesses; and
(ii) representatives of partner organizations involved in the alliances.

Observation was used as a complementary instrument to capture everyday practices, interactions, and operational routines related to production, management, and innovation.

Data Collection

Data collection was conducted in two stages.

The first stage involved group interviews, individual interviews, and on-site observations within the community businesses, focusing on their organizational structures, innovation practices, and experiences with alliances.

The second stage consisted of in-depth individual interviews with key alliance partners, identified during the first stage, to enable data triangulation and enhance analytical validity.

In total, the study comprised approximately 19 hours of observation, 13 interviews with members of six community businesses, and 22 interviews with representatives of 11 partner organizations, resulting in 52 hours of recorded interviews. All interviews were audio-recorded, transcribed using the RESHAPE and TRANSCRIPTOR applications, and analyzed with the support of ATLAS.ti software and Excel spreadsheets



Ethical Considerations

The study was registered on Plataforma Brasil under protocol number 71398223.7.0000.5407.

Results and Findings

This study's results are derived from a qualitative, multiple-case analysis of community-based businesses operating within traditional and Indigenous territories in the Brazilian Amazon. Empirical evidence was generated through semi-structured interviews with community members, cooperative and association leaders, and representatives of partner organizations, complemented by document analysis and direct observations conducted during fieldwork. The data were systematically coded and analyzed using a thematic and comparative approach, enabling the identification of recurring patterns across cases and the construction of analytical categories related to alliance formation, innovation processes, and the role of traditional knowledge. Cross-case comparison was subsequently employed to assess similarities and differences among community businesses and to strengthen the analytical generalization of the findings.

The results demonstrate that alliances are not peripheral arrangements but rather constitute a structural condition for the emergence, consolidation, and continuity of the community-based businesses studied. Across all cases, alliances were present from the early stages of organizational formation and remained central throughout subsequent phases of development. Based on the nature, duration, and depth of collaboration identified during data analysis, two main types of alliances were distinguished: demand-driven alliances and long-term strategic alliances.

Demand-driven alliances are characterized by short-term, project-based collaborations oriented toward specific objectives, such as technical training, capacity building, research and development activities, or the provision of specialized services. These alliances typically involve universities, non-governmental organizations, governmental agencies, or private firms and are mobilized in response to immediate operational or knowledge needs within the communities. Although temporally limited, these collaborations play a significant role in triggering innovation processes by introducing new skills, technologies, or practices into community-based businesses.

In contrast, long-term strategic alliances align with classical definitions of strategic alliances (Todeva & Knoke, 2005; Mowery et al., 1996), involving continuous interaction, shared objectives, and sustained knowledge exchange. These alliances are predominantly formed between community businesses and a multinational cosmetics company, often in conjunction with governmental institutions and other private-sector partners. The longitudinal nature of these relationships enables cumulative learning processes, co-investment in innovation, and the joint development of new production systems. Consistent with Phelps (2010), the findings show that these alliances facilitate the integration of complementary resources and capabilities, wherein partner organizations contribute financial, technological, and managerial expertise, while communities provide in-depth ecological knowledge, experiential understanding of local ecosystems, and traditional practices related to agriculture and extraction.

Technological innovations emerged as a central outcome of these alliances and were identified through the analysis of changes in products, processes, and production systems. One major category of technological innovation concerns the development of new bio-ingredients derived from Amazonian biodiversity, including the domestication and commercial cultivation of native species previously used only for subsistence or cultural purposes. For many communities, the creation of structured supply chains around these species represented a disruptive change, as formal production systems and market-oriented processes had not existed prior to the alliances. These innovations were not solely technological but deeply embedded in biocultural processes that combine scientific knowledge with traditional ecological knowledge, corroborating findings by Davidson-Hunt et al. (2012).

Process innovations were particularly salient in both agricultural and extractive community businesses. Data analysis revealed significant changes in cultivation, harvesting, extraction, and processing techniques, including the introduction of mechanization, improvements in



ergonomics, and the adoption of standardized quality and safety practices. In several cases, traditional slash-and-burn practices were replaced by alternative methods promoted through alliance-based training and technical assistance. While these changes enhanced productivity, environmental compliance, and supply reliability, they also altered long-standing agroextractive techniques, lending empirical support to concerns raised by Tang and Gavin (2016) regarding potential threats to the continuity of traditional ecological knowledge.

Managerial innovations constitute a further dimension of the results and were identified through the examination of organizational structures, governance practices, and administrative routines. The formation and professionalization of associations and cooperatives emerged as a prerequisite for participation in formal markets and alliance-based projects. Training initiatives focused on financial management, production planning, documentation, and the use of digital tools such as spreadsheets, email communication, and computerized accounting systems. These managerial innovations reduced transaction and administrative costs and enabled community businesses to meet formal requirements imposed by partner organizations, in line with Karabulut's (2015) arguments regarding the role of managerial innovation in organizational performance.

Transactional or market innovations were comparatively limited and predominantly incremental. With few exceptions, the commercialization of products resulting from alliance-based innovation occurred primarily through partner organizations, especially the multinational cosmetics company. Only a small number of community businesses diversified their client base or established independent retail channels. This pattern reinforces previous findings on power asymmetries and buyer dependence in sustainable and inclusive value chains (Lima et al., 2024), suggesting that while alliances foster innovation and capacity building, they may also reproduce structural dependencies.

Across all innovation dimensions, traditional knowledge plays a dual role. On the one hand, knowledge related to species identification, medicinal and cosmetic uses, planting cycles, and agroextractive practices functions as a critical foundation for innovation. The integration of this knowledge into alliance-based projects reduced research and development time, enhanced efficiency, and increased the contextual appropriateness of technological solutions, corroborating earlier studies (Ferreira, 1998; Rezende, 2002). On the other hand, the introduction of new technologies, management practices, and market requirements also transformed or displaced certain traditional practices, particularly those related to production processes and organizational forms.

Overall, the results reveal a persistent tension between innovation-driven modernization and the preservation of ancestral knowledge. While alliances enable community businesses to participate in broader innovation systems and value chains, they simultaneously reshape local knowledge systems and socio-technical practices. This tension echoes the concerns raised by Athayde et al. (2017) and highlights critical questions regarding the long-term sustainability, autonomy, and cultural integrity of community-based innovation pathways in the Amazon.



COMMUNITY BUSINESS	Technological Innovation	Operational Innovation	Management Innovation	Transactional Innovation
COOPERATIVE 1	NEW PRODUCTS: BUTTERS AND OILS	NEW COLLECTION AND PRODUCTION TECHNIQUE WITH PPE	INDUSTRIAL BUSINESS MODEL	SALE OF BENEFITED PRODUCTS
		NEW TOOLS FOR THE COLLECTION PROCESS	IMPROVING RELATIONAL CAPACITY	
		OIL AND BUTTER MANUFACTURING	TECHNOLOGICAL TOOLS TO HELP MANAGEMENT	
		QUALITY MANAGEMENT SYSTEM		
		MANUFACTURING PROCESS MANAGEMENT SYSTEM		
		PRODUCTION PLANNING MANAGEMENT		
COOPERATIVE 2	NEW PRODUCTS: MURUMURU AND TUCUMA SEEDS AND MACHINERY	COLLECTION OF NEW PRODUCTS	BUSINESS MODEL	SUPPLY OF SEEDS FOR ORGANIZATION
		NEW TOOLS FOR THE COLLECTION PROCESS		
		NEW COLLECTION AND PRODUCTION TECHNIQUE WITH PPE	TECHNOLOGICAL TOOLS TO HELP MANAGEMENT	
		FACTORY FOR SEED EXTRACTION		
		PRODUCTION PLANNING MANAGEMENT		
ASSOCIATION 1	NEW PRODUCTS: PATAQUEIRA, CAPITIÚ, ESTORAQUE AND PRIPRIOCA ON SCALE	NEW ORGANIC FERTILIZATION TECHNIQUE	BUSINESS MODEL	SUPPLY OF PATAQUEIRA, PRIPRIOCA, ESTORAQUE AND CAPITIÚ FOR ORGANIZATION
		NEW TECHNIQUE WITHOUT BURN	ORGANIZATIONAL STRUCTURE	
		MECHANIZATION OF AGRICULTURAL MANAGEMENT	IMPROVING RELATIONAL CAPACITY	
		USE OF PPE	TECHNOLOGICAL TOOLS TO HELP MANAGEMENT	
		PRODUCTION WITH IRRIGATION ON SITE		
		PRODUCTION PLANNING MANAGEMENT		
		QUALITY MANAGEMENT SYSTEM		
ASSOCIATION 2	NEW PRODUCTS: PATAQUEIRA, CAPITIÚ, ESTORAQUE AND PRIPRIOCA ON SCALE	FACTORY CONSTRUCTION	BUSINESS MODEL	SUPPLY OF PATAQUEIRA, PRIPRIOCA, ESTORAQUE AND CAPITIÚ FOR ORGANIZATION
		NEW ORGANIC FERTILIZATION TECHNIQUE	ORGANIZATIONAL STRUCTURE	
		NEW TECHNIQUE WITHOUT BURN	IMPROVING RELATIONAL CAPACITY	
		MECHANIZATION OF AGRICULTURAL MANAGEMENT		
		NEW COLLECTION TECHNIQUE WITH PPE	TECHNOLOGICAL TOOLS TO HELP MANAGEMENT	
		PRODUCTION WITH IRRIGATION ON SITE		
ASSOCIATION 3	NEW PRODUCTS: MURUMURU AND ANDIROBA SEEDS	MURUMURU COLLECTION	IMPROVING RELATIONAL CAPACITY	SUPPLY OF SEEDS FOR ORGANIZATION
		NEW COLLECTION TECHNIQUE WITH PPE		
		SEED EXTRACTION PROCESS		
ASSOCIATION 4	NEW PRODUCTS: PRIPRIOCA	PRIPRIOCA HARVESTING PROCESS	BUSINESS MODEL	SUPPLY OF PRIPRIOCA TO ORGANIZATION
			IMPROVING RELATIONAL CAPACITY	
			STRATEGIC PLANNING	NEW SALES CHANNELS
			PROJECT MANAGEMENT	



Authors (2025)

Managerial Implications

This study offers several managerial implications for firms, policymakers, NGOs, and community leaders engaged in partnerships with traditional communities.

First, the findings highlight that alliances with traditional communities should be managed as long-term strategic relationships, rather than transactional supply arrangements. Managers should recognize traditional knowledge as a strategic resource (Barney, 1991) and invest in trust-building, continuous engagement, and reciprocal learning.

Second, organizations engaging in these alliances should design innovation processes that explicitly integrate traditional knowledge, rather than merely extracting it. Participatory approaches, co-development of technologies, and shared decision-making mechanisms are recommended to avoid the erosion of local practices and social legitimacy.

Third, there is a need to strengthen managerial and commercial capabilities within community businesses, particularly in market access, negotiation, and diversification of clients. Overreliance on a single buyer increases vulnerability and limits value capture by communities.

Fourth, policymakers and supporting institutions should align innovation incentives with cultural and environmental safeguards, ensuring that imposed innovations do not undermine social cohesion or ecological balance. Benefit-sharing mechanisms and formal recognition of traditional knowledge are critical tools in this process.

Conclusions and Future Research

This study contributes to the literature by demonstrating how organizational alliances foster multiple forms of innovation in traditional community businesses in the Amazon, while simultaneously reshaping indigenous and traditional knowledge systems. Technological, operational, managerial, and transactional innovations were identified as outcomes of these alliances, highlighting both opportunities and risks.

The findings suggest that while innovation can enhance economic inclusion and organizational resilience, it may also interfere with ancestral practices, particularly when driven by external market logics. Thus, innovation in traditional contexts should not be understood as inherently positive, but rather as a process requiring careful governance, ethical engagement, and contextual sensitivity.

From a theoretical perspective, the study extends innovation and strategic alliance literature by incorporating traditional knowledge as a dynamic, contested resource within inter-organizational relationships. It also contributes to debates on sustainable development by revealing tensions between modernization and cultural preservation.

This study has limitations. The sample included a limited diversity of alliance configurations, and the analysis was conducted primarily at the organizational level rather than at the product or intergenerational knowledge-transfer level. These limitations open avenues for future research. Future studies could: examine innovation processes at the product level, tracing how specific traditional practices evolve; adopt longitudinal designs to assess long-term impacts on cultural resilience; compare alliance models across different regions or countries; and investigate governance mechanisms that balance innovation with the safeguarding of traditional knowledge.

By shedding light on these dynamics, this research advances understanding of how sustainable and inclusive business models can be developed in the Amazon with the active protagonism of traditional communities.



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Analyzing Energy Consumption at fluctuating hydraulic retention time in a climate-changing environment: A study of the aerobic biological treatment process

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Abstract

The aerobic biological process utilizes active microbes to reduce organic and inorganic materials to acceptable standards, at a design (four to six) hydraulic retention time. The hydraulic retention time is sufficient to ensure that microbes acclimatize to the environment and that oxygen saturation takes place in the aerobic biological process. However, in a climate-changing environment where temperatures are changing as a result of global warming in the atmosphere, the four to six hours of hydraulic retention time could be affected. This is because the climate temperature rise affects the solubility of oxygen in water bodies, which forces plant supervisors to increase aeration, resulting in high energy consumption. Hence, this study will analyse energy consumption at fluctuating hydraulic retention time in a climate-changing environment. The results of the study showed that COD and ammonia removal increased, while nitrate accumulated with an increase in climate-rising temperatures. COD removal at 18°C, 20°C, 22°C, and 24°C were 78 mg/L, 82 mg/L, 94 mg/L, and 148 mg/L, respectively. The percentage differences were 4.9%, 12.8%, and 36.5%, between climate temperatures 18°C and 20°C, 20°C and 22°C, and 22°C and 24°C, respectively, which was similar for ammonia removal and nitrate accumulation. The energy consumed per mg/L COD removal was 0.00112 kWh/mg/L for a climate temperature of 18°C, while at a climate temperature of 24°C, energy consumed per COD removal was 0.00059 kWh/mg/L at hydraulic retention times of 4 hours, respectively. This was a difference of 47.3%, which shows that rising climate temperatures benefit the aerobic biological process. The ANOVA test supported the results and produced *P* values of COD (*P* = 0.000913) and ammonia (*P* = 0.0000012). The same was observed for nitrate accumulation and ammonia removal. Therefore, rising climate temperatures are beneficial in the aerobic biological process.

Keywords: Wastewater treatment; aerobic biological process; Chemical oxygen demand; Ammonia; Nitrate; Climate change; Hydraulic retention time



Introduction

Background

Municipal wastewater treatment plants are critical for purifying wastewater emanating from domestic, and industrial areas (Sikosana et al. 2019). A municipal wastewater treatment plant comprises three standard processes: physical, biological, and chemical. The physical treatment process is applied to ensure that large objects such as rags and plastics, leaves and sticks, and bottles are removed and later disposed (Saleh et al. 2020). The biological process is applied to ensure that organic and inorganic materials such as fats, natural gases, minerals, and acids are reduced to acceptable standards (Singh et al. 2024). The chemical process is applied to ensure that harmful microbes are killed, while the treated wastewater is neutralized, before discharging into the environment (Gupta et al. 2012). The three processes are essential to ensure that the purification process is achieved successfully.

The aerobic biological process utilizes active microbes to reduce organic and inorganic materials to acceptable standards. The wastewater acceptable effluent standards are presented in Table 1 (Department of Environmental Affairs 2014). The active microbes are readily available in the wastewater, however, they require oxygen for respiration, hence, this process is referred to as an aerobic biological process (Drewnowski et al. 2019). The general chemical reaction that represents the removal of organic and inorganic matter is shown in Equations 1, 2, and 3 respectively. The organic and inorganic matter is measured using biochemical oxygen demand or chemical oxygen demand, and ammonia nitrogen, respectively. Oxygen is supplied to the wastewater by air by means of surface aerators or subsurface aerators, either by blowing air using blowers or pumps (Rosso et al. 2008). The air blowers consume extreme levels of energy since they operate 24 hours non-stop, which compromises Sustainable Development Goals (SDGs) 7 and 13. In Italy, the aerobic biological process was reported to consume on average 1.02 kilowatt hour per cubic meter (kWh/m³), which is 42% of the energy consumed by an entire wastewater treatment plant (Ranieri et al. 2021). Similarly, in South Africa, the energy consumption of two wastewater treatment plants: Zeekoegat and JP Marais was analysed, and the results showed that they consumed 4742823 kWh per year, which amounts to 42.2% of the total energy consumed by the plant (Musvoto and Ikumi 2016). This energy consumption is high and comprises SDGs 7 and 13.

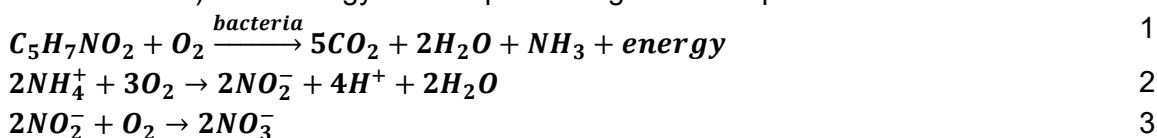


Table 1: Wastewater Effluent Discharge Standard (Department of Environmental Affairs. 2014)

No	Parameter	Units	General Standards
1	pH	N/A	5.5 - 7.5
2	DO	mg/l	<10
3	Temperature	°c	<35
4	COD	mg/l	<75
5	BOD	mg/l	<30
6	Suspended Solids	mg/l	<90
7	Free and saline ammonia	mg/l	<1



The extreme energy consumption is caused by the oxygen supply for the entire hydraulic retention time (4 – 6 hours) in the aerobic biological process. Hydraulic retention time is the time required for the wastewater to remain in the aerobic biological process, to allow for organic and inorganic reduction (Muloiwa et al. 2024). The design of the aerobic biological process differs based on the concentration of wastewater being treated, however, they typically operate on hydraulic retention times between four and six hours (Metcalf & Eddy, A.E.C.O.M., 2014; Spellman 2008). The hydraulic retention time is sufficient to ensure that microbes acclimatize to the environment and that oxygen saturation takes place in the aerobic biological process. However, in a climate-changing environment where temperatures are changing as a result of global warming in the atmosphere, affecting both land and ocean, the four to six hours hydraulic retention time could be affected (NOAA National Centres for Environmental Information). This is because the climate temperature rise affects the solubility of oxygen in water bodies, which is a major problem (Wilén 2010). The effect of climate temperatures on oxygen solubility will suffocate microbes, resulting in slow acclimation and poor oxygen saturation in the aerobic biological process (Alisawi 2020). Several studies reported that rising temperatures affect the solubility of oxygen. For example, at 4°C, the dissolved oxygen concentration is 10.92 mg/L, while at a temperature of 21°C, the dissolved oxygen concentration was 8.68 mg/L (Walczyńska and Sobczyk 2017). This is a 20.5% decrease in oxygen concentration. Furthermore, when the solubility of oxygen is insufficient, plant supervisors will be forced to increase aeration rates, which further consumes energy, compromising SDG No 7 and 13. For example, Sun et al. (2016) reported that when the aerobic biological process aeration rates were reduced by 20%, the overall energy consumption was reduced by 4%. Despite the rise in climate temperatures affecting oxygen solubility, Farajzadehha et al. (2022) reported that high COD removal compared to low climate temperatures. The COD removal values were 64% and 71%, 73% and 78%, for 20°C and 35°C temperatures respectively. Furthermore, the rise in climate temperatures was reported to benefit the COD removal compared with low climate temperatures measured at various hydraulic retention times. At a hydraulic retention time of six hours, high climate temperatures produced 90% removal, while at low temperature produced 86%. At a hydraulic retention time of nine hours, high climate temperatures produced 95% removal, while at low temperature produced 92%. This literature suggests that high climate temperatures are most likely to benefit the COD removal.

On the other side, microbes thrive in a warm environment, which increases their metabolism, resulting in a rapid increase in their population. Several studies have reported that at higher climate temperatures, the population of microbes increases at a higher rate. For example, Qiu et al. (2002) reported that when climate temperatures increased from 26°C to 34°C, the microbes' growth increased by at least 262 times. Muloiwa et al. (2023) reported that microbes increased with an increase in the climate temperatures from 2.678 g/L to 6.512 g/L between 18°C and 32.5°C respectively. As per the literature above, it is clear that climate temperature will have an impact on microbes and oxygen solubility in the aerobic biological process, and the rate of temperature increase is rising. Figure 1 presents global ocean water temperature anomalies from the year 1977 – 2025, which shows that climate temperatures are increasing (NOAA National Centres for Environmental Information, Monthly Global Climate Report for June 2025). The linear trendline shows that ocean water temperature is increasing at a rate of 0.0122°C annually, which will be the same for wastewater on the surface. At this rising climate temperature, the aerobic biological treatment process will have to be analysed since



microbes and oxygen are affected by temperature changes, which is likely to have an impact on energy consumption (Muloiwa et al. 2023). Therefore, since there is a conflict on the impact of climate temperatures on oxygen and microbes' growth, it will be worth analysing the impact of climate temperature changes at different hydraulic retention times in the aerobic biological process. The analysis will reveal whether the longer hydraulic retention times are required to still achieve the reduction of organic and inorganic matter, at minimal energy consumption.

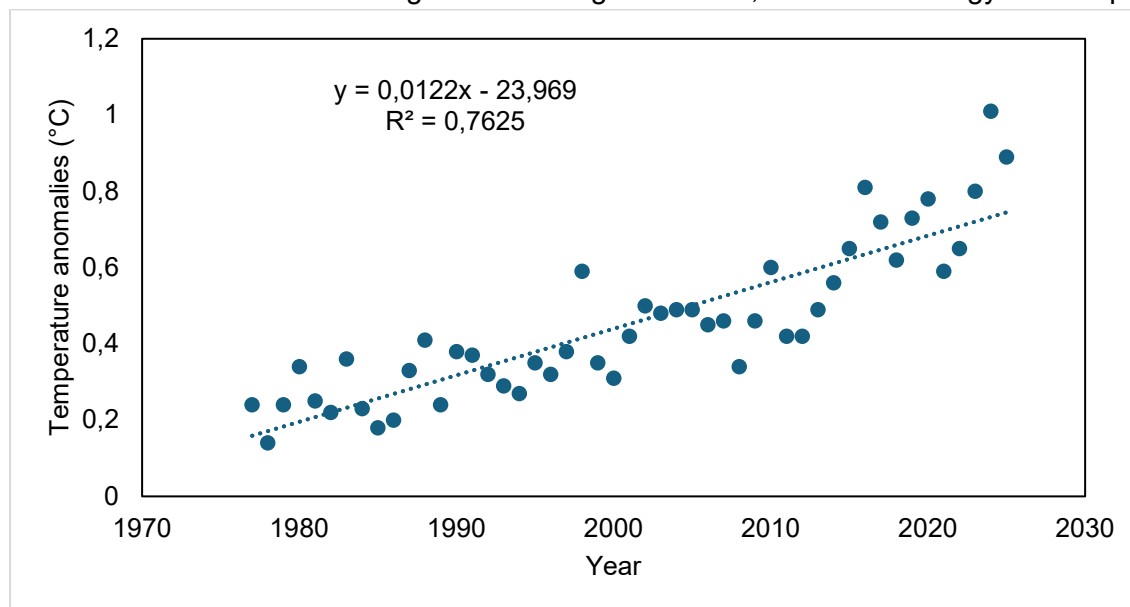


Figure 2: Global ocean water temperature anomalies 1977 – 2025 (NOAA National Centres for Environmental Information, Monthly Global Climate Report for June 2025)

Problem Statement

The aerobic biological process consumes extreme amounts of energy primarily due to the oxygen supply over the entire hydraulic retention time. With the climate changing temperature that affects oxygen solubility, plant supervisors will be forced to apply longer hydraulic retention times in order to ensure that oxygen dissolves in the wastewater aerobic biological process. Longer hydraulic retention times result in excessive energy consumption.

The main objective of the study was to analyze energy consumption at fluctuating hydraulic retention time in a climate-changing environment. The specific objectives are detailed below.

- Analyse the effect of climate temperature change on COD removal energy consumption at varying hydraulic retention times.
- Analyse the effect of climate temperature change on ammonia removal energy consumption at varying hydraulic retention times.
- Analyse the effect of climate temperature change on nitrate accumulation energy consumption at varying hydraulic retention times.

The following hypotheses were formulated for the study:

H₀: Is there no statistical difference in the effect of climate temperature changes on COD, and ammonia, and nitrate accumulation removal energy consumption?

H₁: Is there a statistical difference in the effect of climate temperature changes on COD, and ammonia removal, and nitrate accumulation energy consumption?



Research Design and Methodology

Laboratory set-up

An aerobic biological process was set up at the Civil Engineering Department, at Tshwane University of Technology. The aerobic biological process is shown in Figure 2 and consisted of the following:

- Aeration tank
- Air pump
- Airflow meter
- Air diffuser
- Thermostat

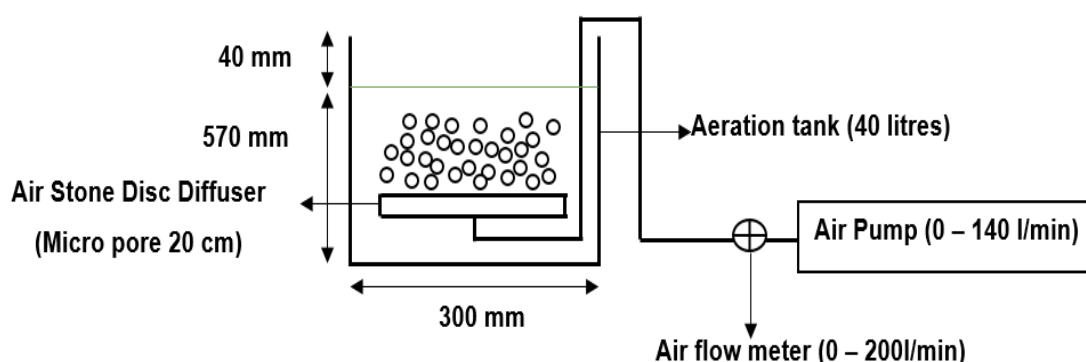


Figure 3: laboratory aerobic biological process

Wastewater collection, aeration, and disposal

Wastewater was collected from the Daspoort wastewater treatment plant located in the City of Tshwane, South Africa. Wastewater was collected in accordance with the American Public Health Association (APHA, 2012), to ensure health and safety procedures are adhered to. Aeration was performed twice a day for a period of 162 days, which enabled a total of 324 data points. The data used was the average of three samples, which had a variation of between ± 0.6 mg/L. Four climate temperatures were applied: 18°C, 20°C, 22°C, and 24°C, representing cold and warm wastewater. The airflow rate was maintained at 5 litres per minute, to ensure consistency of dissolved oxygen concentration in the aerobic biological process. A four-hour hydraulic retention time was applied in the aerobic biological process, which mimicked the applications at the Daspoort wastewater treatment process. After the completion of the aeration process, wastewater was disposed of at the ablution facilities, ensuring that it returns to the wastewater treatment plant.

Wastewater characteristics measurement

Wastewater characteristics of interest in the aerobic biological process were COD, ammonia, and nitrate. The wastewater was sampled and measured every hour from initial concentration (before aeration) to final concentration (4 hours). The wastewater characteristics were measured using the Standard Methods for the Examination of Water and Wastewater as follows:

- COD – APHA method 5220
- Ammonia – APHA (2012) method 4500
- Nitrate – APHA (2012) method 4500.



Wastewater analysis

Energy consumption was measured using a digital watt meter, and the unit measurement used was kilowatt-hour (kWh). The total energy consumption was analysed by dividing the energy consumption by the COD and ammonia removal range as shown in Equation 4. The wastewater characteristics were analysed using descriptive statistics and inferential statistics. Descriptive statistics applied were range (Equation 4) and percentages (Equation 5), while the inferential statistics applied were the ANOVA.

$$\text{Energy consumption} = \text{energy consumption per COD/ammonia removal (kWh/mg/L)} \quad 4$$

$$\text{Range} = \text{initial concentration} - \text{final concentration (mg/L)} \quad 5$$

$$\text{Percentage} = \frac{\text{initial-final}}{\text{final}} (\%) \quad 6$$

The ANOVA was performed on Microsoft Excel to test the hypothesis. The hypothesis was tested on two temperatures: 18°C and 24°C. The ANOVA test was applied at a 95% degree of freedom. The ANOVA test was performed on the 324 data points collected during the experiments. The hypotheses are presented below.

- Is there a statistical difference in the effect of climate temperature changes on COD and ammonia removal energy consumption?
- Is there no statistical difference in the effect of climate temperature changes on COD and ammonia removal energy consumption?

Ethical Considerations

Permission to sample wastewater at the Daspoort wastewater treatment plant was granted by the plant manager.

Results and Findings

4.1 COD removal energy consumption analysis

Figure 3 presents the COD concentration measured at different hydraulic retention times in the aerobic biological process, during different climate temperatures. At a climate temperature of 24°C, the initial concentration was 178 mg/L, and the final concentration was 30 mg/L, which shows a 148 mg/L COD removal. At a climate temperature of 18°C, the initial concentration was 122 mg/L, and the final concentration was 44 mg/L, which shows a 78 mg/L COD removal. The difference between 24°C and 18°C climate temperatures on COD removal was 70 mg/L, which amounts to a 47.3% difference. This means that higher climate temperatures support better COD removal compared to lower climate temperatures. This also supports the literature on the fact that higher climate temperatures support microbes' growth, which influences COD elimination in the aerobic biological process. In addition, microbes that are found in wastewater fall within the mesophilic category, and they have a growth range between climate temperatures 10°C – 45°C, hence a superior performance (Alisawi 2020). The same was observed at the climate temperatures of 20°C and 22°C. The overall results show that the COD removal at 18°C, 20°C, 22°C, and 24°C were 78 mg/L, 82 mg/L, 94 mg/L, and 148 mg/L, respectively. The percentage differences were 4.9%, 12.8%, and 36.5%, between climate temperatures 18°C and 20°C, 20°C and 22°C, and 22°C and 24°C, respectively. These results are consistent with the results reported by Farajzadehha et al. (2022) and Tee et al. (2017). The results show that as the global climate temperature rises in surface waters, there is a significant benefit in the aerobic biological process. All climate temperatures analysed showed



that hydraulic retention time should be reduced to two hours, without compromising the effluent discharge standards of 75 mg/L.

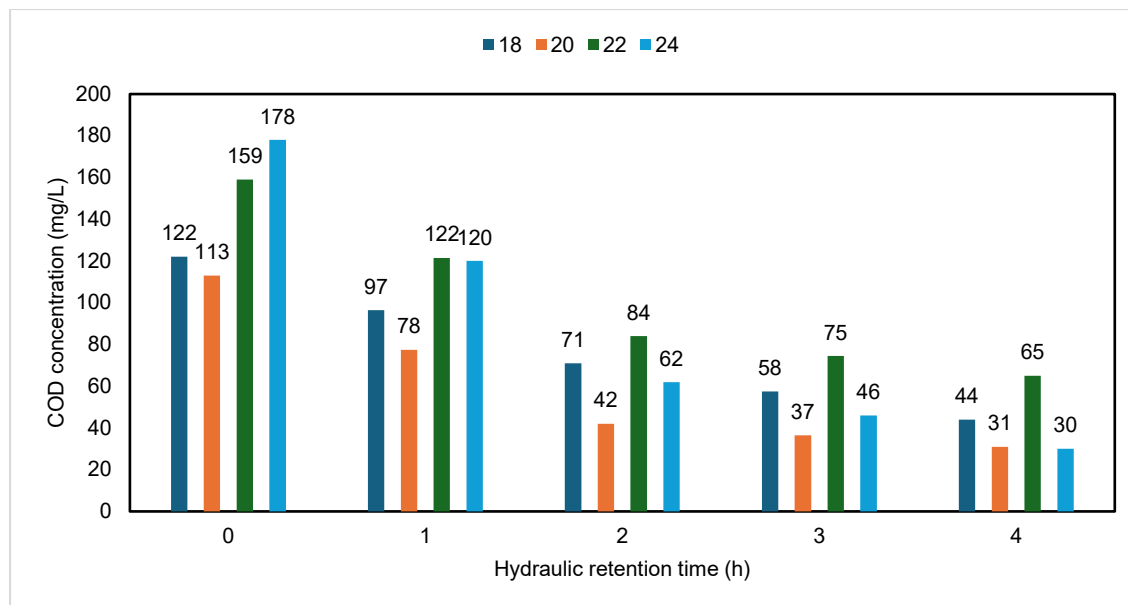


Figure 4: COD concentration measured at different hydraulic retention times in the aerobic biological process

Figure 4 presents COD removal measured at different energy consumption in the aerobic biological treatment process, during different climate temperatures. The results indicate that higher climate temperatures eliminated COD concentration per energy consumed much superior. At 0.02175 kWh energy consumption, COD removals were 26 mg/L, 36 mg/L, 38 mg/L, and 58 mg/L, measured at climate temperatures of 18°C, 20°C, 22°C, and 24°C, respectively. This was a difference of 27.8%, 5.3%, and 34.5% between climate temperatures 18°C and 20°C, 20°C and 22°C, and 22°C and 24°C, respectively. This suggests that higher climate temperatures support rapid COD removal, therefore, in a climate-changing environment where temperatures are increasing, shorter hydraulic retention times should be applied. Similar results are observed at 0.0435 kWh energy consumption. COD removals were 51 mg/L, 71 mg/L, 75 mg/L, and 116 mg/L, measured at climate temperatures of 18°C, 20°C, 22°C, and 24°C, respectively. This was a difference of 28.2%, 5.3%, and 35.3% between climate temperatures 18°C and 20°C, 20°C and 22°C, and 22°C and 24°C, respectively. Likewise, at 0.06525 kWh energy consumption, COD removals were 65 mg/L, 77 mg/L, 85 mg/L, and 132 mg/L, measured at climate temperatures of 18°C, 20°C, 22°C, and 24°C, respectively. This was a difference of 15.6%, 9.4%, and 35.6% between climate temperatures 18°C and 20°C, 20°C and 22°C, and 22°C and 24°C, respectively. Lastly, at 0.087 kWh energy consumption, COD removals were 78 mg/L, 82 mg/L, 94 mg/L, and 148 mg/L, measured at climate temperatures of 18°C, 20°C, 22°C, and 24°C, respectively. This was a difference of 4.9%, 12.8%, and 36.5% between climate temperatures 18°C and 20°C, 20°C and 22°C, and 22°C and 24°C, respectively. The overall COD removal at four-hour hydraulic retention time and at climate temperatures of 18°C, 20°C, 22°C, and 24°C were 78 mg/L, 82 mg/L, 94 mg/L, and 148 mg/L, at an energy consumption of 0.087 kWh. It is clear that higher climate temperatures achieve high COD removal, therefore, plant supervisors must take advantage of the rising climate temperatures and reduce the hydraulic retention times, which will reduce



energy consumption in the aerobic biological process. The application of high climate temperatures and shorter hydraulic retention time will result in low energy consumption, without compromising effluent quality standards.

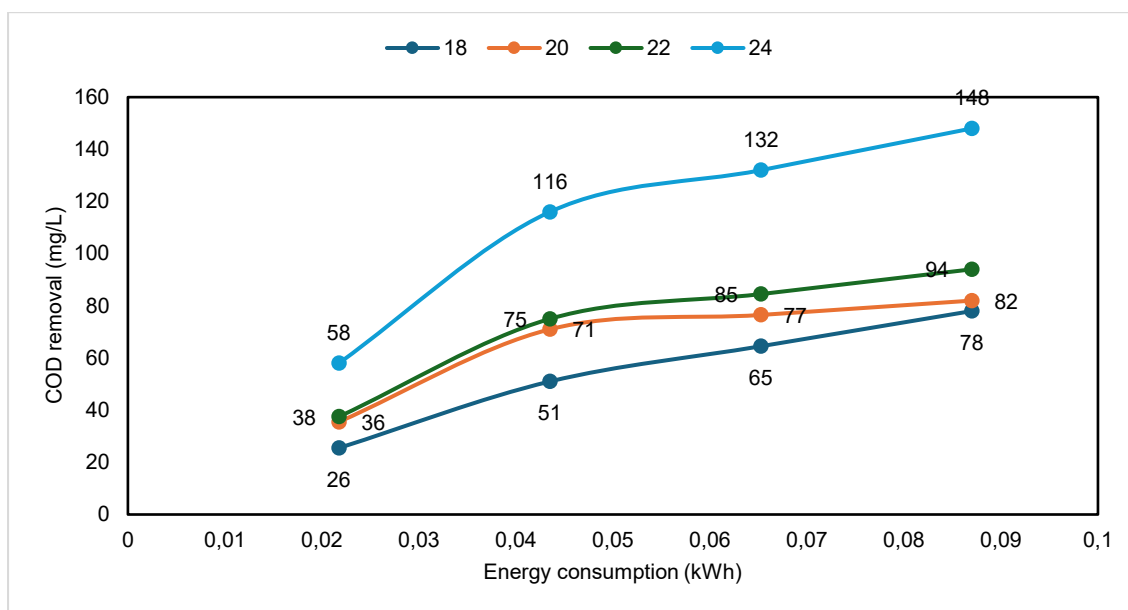


Figure 5: COD removal measured at different energy consumption in the aerobic biological process

Figure 5 presents energy consumed per mg/L COD removal at different hydraulic retention times, while Table 1 presents the percentage difference for energy consumed per COD removal difference in the aerobic biological process. The energy consumed per mg/L COD removal was 0.00085 kWh/mg/L, 0.00085 kWh/mg/L, 0.00101 kWh/mg/L, and 0.00112 kWh/mg/L for a climate temperature of 18°C. At a climate temperature of 20°C, energy consumed per mg/L COD removal was 0.00061 kWh/mg/L, 0.00061 kWh/mg/L, 0.00085 kWh/mg/L, and 0.00106 kWh/mg/L, at hydraulic retention times of 1, 2, 3, and 4 hours, respectively. Comparing climate temperatures of 18°C and 20°C, it shows that there is a 28.2%, 28.2%, 15.7%, and 4.9% energy saving as a result of a rise in climate temperatures.

Similarly, at a climate temperature of 22°C, energy consumed per COD removal was 0.00058 kWh/mg/L, 0.00058 kWh/mg/L, 0.00077 kWh/mg/L, and 0.00093 kWh/mg/L at hydraulic retention times of 1, 2, 3, and 4 hours, respectively. Comparing climate temperatures 20°C and 22°C, it shows that there is a 5.3%, 5.3%, 9.5%, and 12.8% energy saving as a result of a rise in climate temperatures. Lastly, at a climate temperature of 24°C, energy consumed per COD removal was 0.00038 kWh/mg/L, 0.00038 kWh/mg/L, 0.00049 kWh/mg/L, and 0.00059 kWh/mg/L at hydraulic retention times of 1, 2, 3, and 4 hours, respectively. Comparing the climate temperatures of 22°C and 24°C, it shows that there is a 35.3%, 35.3%, 36%, and 36.5% energy saving as a result of a rise in climate temperatures. The overall energy consumption saving between 18°C and 24°C were 56%, 56%, 51.1%, and 47.3% at hydraulic retention times of 1, 2, 3, and 4 hours. At higher climate temperatures, mg/L COD removal is less compared to lower climate temperatures. The results obtained in this study were lower than values reported by other scholars. Marner et al. (2016) reported a specific energy consumption of 3.53 kWh/kg COD while Macintosh et al. (2019) reported 6.02 kWh/kg COD.



Scholars that reported values that were closer to this study were Panepinto et al. (2016) and Turkmenler (2019), with values 0.823 kWh/kg COD and 0.665 kWh/kg COD respectively.

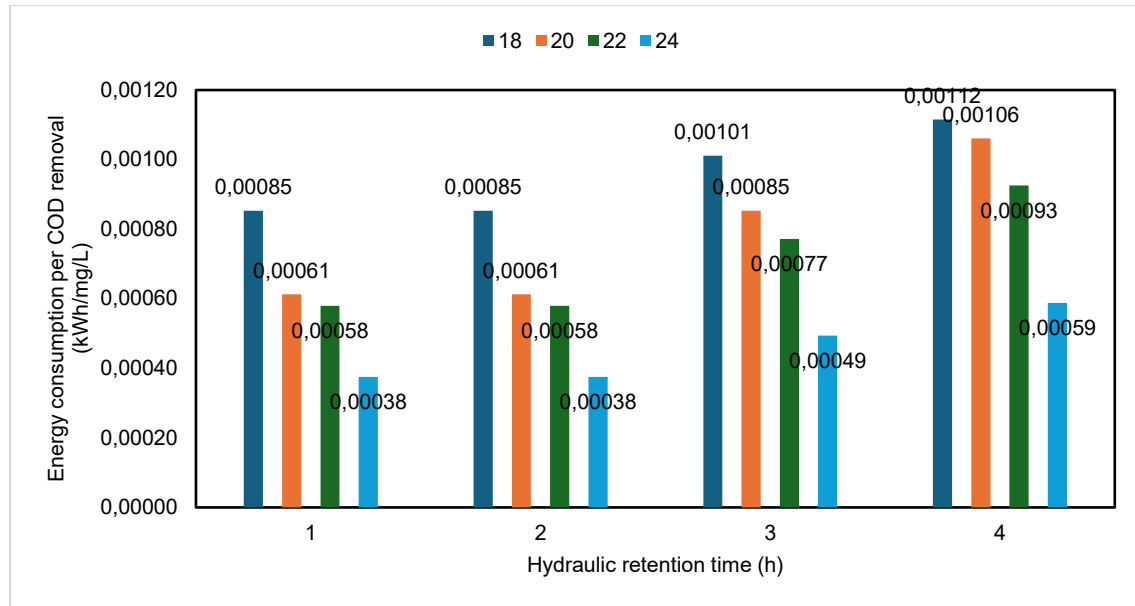


Figure 6: Energy consumed per COD removal at different hydraulic retention times

Table 2: Percentage difference between energy consumed

Energy consumption (kWh)	18°C – 20°C (%)	20°C – 22°C (%)	22°C – 24°C (%)	18°C – 24°C (%)
0.02175	28.2	5.3	35.3	56.0
0.0435	28.2	5.3	35.3	56.0
0.06525	15.7	9.5	36.0	51.1
0.087	4.9	12.8	36.5	47.3

4.2 Ammonia removal energy consumption analysis

Figure 6 presents the ammonia concentration measured at different hydraulic retention times in the aerobic biological process, during different climate temperatures. At a climate temperature of 24°C, the initial concentration was 14 mg/L, and the final concentration was 4 mg/L, which shows a 10 mg/L ammonia removal. At a climate temperature of 18°C, the initial concentration was 13 mg/L, and the final concentration was 9 mg/L, showing a 4 mg/L ammonia removal. The difference between 24°C and 18°C climate temperatures on ammonia removal was 6 mg/L, which amounts to a 60% difference. Similar to COD removal, the ammonia results show that as the global climate temperatures rise in surface waters, there is a significant benefit in the aerobic biological process, and both organic and inorganic materials will be reduced. The same was observed at the climate temperatures of 20°C and 22°C. The results show that the ammonia removal at 18°C, 20°C, 22°C, and 24°C were 4 mg/L, 5 mg/L, 8 mg/L, and 10 mg/L, respectively, which is an increasing trend. The percentage differences



were 20%, 37.5%, and 20%, between climate temperatures 18°C and 20°C, 20°C and 22°C, and 22°C and 24°C, respectively. However, the hydraulic retention time of four hours did not achieve the ammonia effluent discharge standard of 1 mg/L in all climate temperatures. The results obtained in this study were consistent with results obtained by other scholars. Zangeneh et al. (2021) reported the highest ammonia removal (98%) at climate temperatures of 45.8°C and the lowest (6.6%) at 34°C. Nengzi et al. (2023) reported 98.4%, 95.58%, and 85.04% at climate temperatures of 24°C, 16°C, and 8°C respectively.

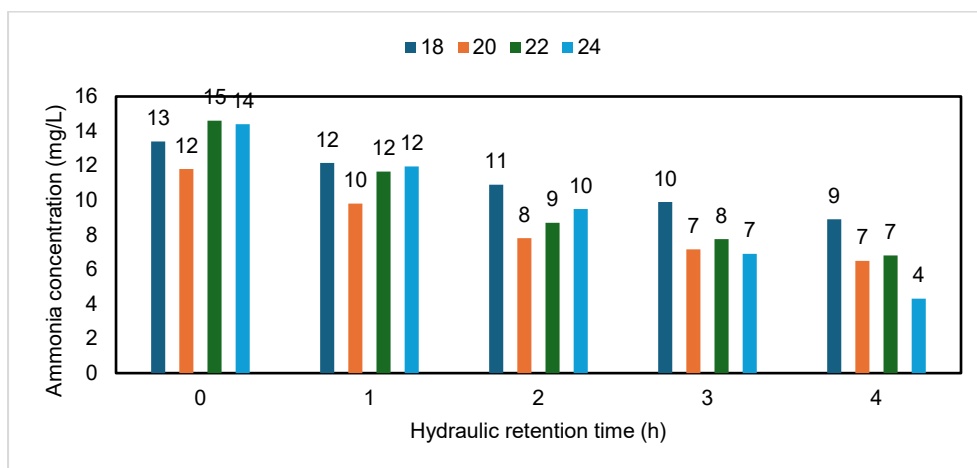


Figure 7: Ammonia concentration measured at different hydraulic retention times in the aerobic biological process

Figure 7 presents ammonia removal measured at different energy consumption in the aerobic biological treatment process. Similar results to COD removal were observed. The results indicate that higher climate temperatures eliminated ammonia concentration per energy consumed superior compared to lower climate temperatures. At 0.02175 kWh energy consumption, ammonia removals were 1 mg/L, 2 mg/L, 2 mg/L, and 3 mg/L, measured at climate temperatures of 18°C, 20°C, 22°C, and 24°C, respectively. This was a difference of 50%, 0%, and 33.3% (negative) between climate temperatures 18°C and 20°C, 20°C and 22°C, and 22°C and 24°C, respectively. The results obtained at 0.0435 kWh energy consumption were similar to the results obtained at 0.02175 kWh. The ammonia removals were 3 mg/L, 4 mg/L, 6 mg/L, and 5 mg/L, measured at climate temperatures of 18°C, 20°C, 22°C, and 24°C, respectively. This was a difference of 25%, 33.3%, and 16.7% (negative) between climate temperatures 18°C and 20°C, 20°C and 22°C, and 22°C and 24°C, respectively. The negative percentage difference between 22°C and 24°C was caused by the better ammonia removal performance of the climate temperature 22°C compared to 24°C.

At 0.06525 kWh energy consumption, ammonia removals were 4 mg/L, 5 mg/L, 7 mg/L, and 8 mg/L, measured at climate temperatures of 18°C, 20°C, 22°C, and 24°C, respectively. This was a difference of 20%, 28.6%, and 12.5% between climate temperatures 18°C and 20°C, 20°C and 22°C, and 22°C and 24°C, respectively. Lastly, at 0.087 kWh energy consumption, ammonia removals were 5 mg/L, 5 mg/L, 8 mg/L, and 10 mg/L, measured at climate temperatures of 18°C, 20°C, 22°C, and 24°C, respectively. This was a difference of 0%, 37.5%, and 20% between climate temperatures 18°C and 20°C, 20°C and 22°C, and 22°C and 24°C, respectively. The overall ammonia removal at climate temperatures of 18°C, 20°C, 22°C, and 24°C were 5 mg/L, 5 mg/L, 8 mg/L, and 10 mg/L, at an energy consumption of 0.087 kWh. The results presented in this study indicate that as climate temperatures increase,



less energy is required for ammonia removal. This suggests that reducing hydraulic retention times is essential to lower energy consumption without violating effluent quality standards. The warmer environment created by rising climate temperatures, provides ideal conditions for the metabolic rate of microbes to increase, resulting in rapid ammonia removal.

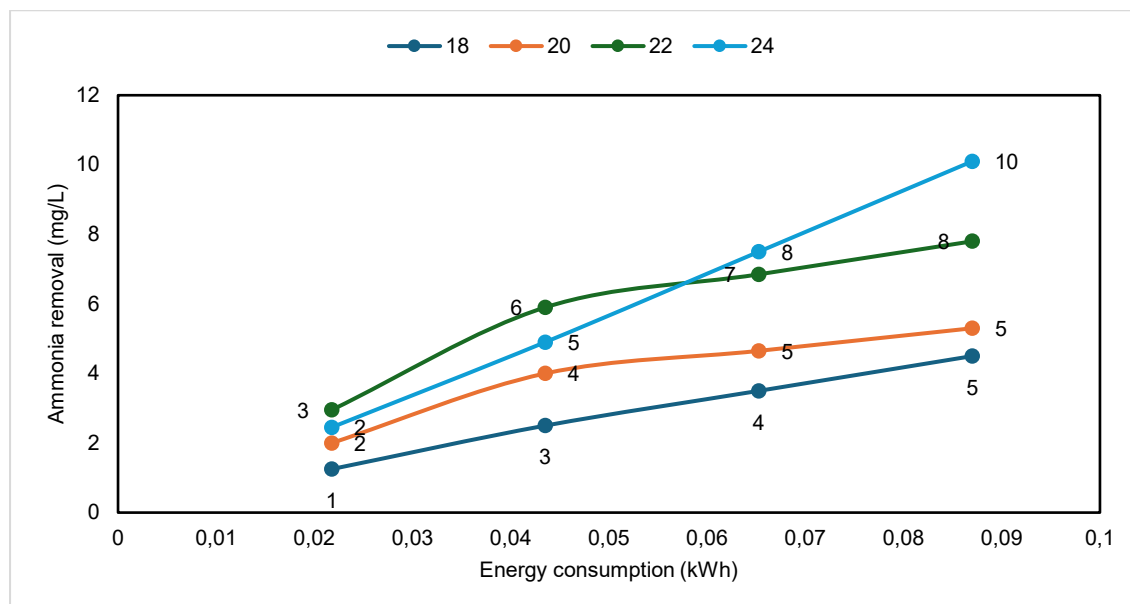


Figure 8: Ammonia removal measured at different energy consumption in the aerobic biological process

Figure 8 presents energy consumed per ammonia removal at different hydraulic retention times, while Table 3 presents the percentage difference for energy consumed per ammonia removal difference for in the aerobic biological process. The energy consumed per ammonia removal was 0.01740 kWh/mg/L, 0.01740 kWh/mg/L, 0.01864 kWh/mg/L, 0.01933 kWh/mg/L for a climate temperature of 18°C. At a climate temperature of 20°C, energy consumed per ammonia removal was 0.01088 kWh/mg/L, 0.01088 kWh/mg/L, 0.01403 kWh/mg/L, and 0.01642 kWh/mg/L, at hydraulic retention times of 1, 2, 3, and 4 hours, respectively. Comparing climate temperatures of 18°C and 20°C, it shows that there is a 37.5%, 37.5%, 24.7%, and 15.1% energy saving as a result of a rise in climate temperatures. At a climate temperature of 22°C, energy consumed per ammonia removal was 0.00737 kWh/mg/L, 0.00737 kWh/mg/L, 0.00953 kWh/mg/L, and 0.0115 kWh/mg/L at hydraulic retention times of 1, 2, 3, and 4 hours, respectively. Comparing climate temperatures of 20°C and 22°C, it shows that there is a 32.2%, 32.2%, 32.1%, and 32.1% energy saving as a result of a rise in climate temperatures. At a climate temperature of 24°C, energy consumed per ammonia removal was 0.00888 kWh/mg/L, 0.00888 kWh/mg/L, 0.00870 kWh/mg/L, and 0.00861 kWh/mg/L at hydraulic retention times of 1, 2, 3, and 4 hours, respectively. Comparing the climate temperatures of 22°C and 24°C, it shows that there is a 20.4% (negative), 20.4% (negative), 8.7%, and 22.8% energy saving as a result of a rise in climate temperatures. The overall energy consumption savings between 18°C and 24°C were 49%, 49%, 53.3%, and 55.4% at hydraulic retention times of 1, 2, 3, and 4 hours. The negative percentage difference between 22°C and 24°C was caused by the better ammonia removal performance at a climate temperature of 22°C compared to 24°C. The results were slightly different to COD removal energy consumption reported in section 4.1. The ammonia overall results show an increasing



trend from 49% to 55.4%, while the COD overall results showed a decreasing trend from 56% to 47.3%. This is because heterotrophic bacteria, responsible for COD removal, suppress autotrophic bacteria, responsible for ammonia removal. Hence, the autotrophic bacteria become active when the nutrients of the heterotrophic bacteria are used up. The results presented in this study were superior to the results reported by scholars in the literature. Scholars Ward et al. (2018), Van Linden et al. (2020), Zhang et al. (2018), Sakar et al. (2019), and Fang et al. (2018) reported 4.9 kWh/kg ammonia nitrogen, 5.28 kWh/kg ammonia nitrogen, 20.4 kWh/kg ammonia nitrogen, 8 kWh/kg ammonia nitrogen, and 4.6 kWh/kg ammonia nitrogen respectively.

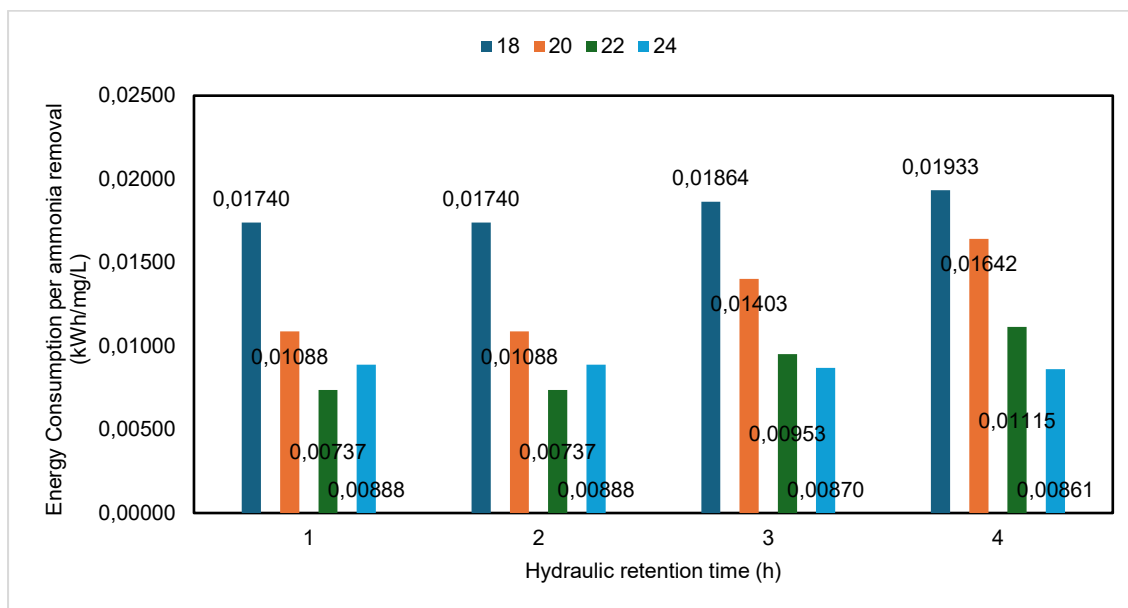


Figure 9: Energy consumed per ammonia removal at different hydraulic retention times

Table 3: Percentage difference between energy consumed

Energy consumption (kWh)	18°C – 20°C (%)	20°C – 22°C (%)	22°C – 24°C (%)	18°C – 24°C (%)
0.02175	37.5	32.2	-20.4	49.0
0.0435	37.5	32.2	-20.4	49.0
0.06525	24.7	32.1	8.7	53.3
0.087	15.1	32.1	22.8	55.4

4.3 Nitrate accumulation energy consumption analysis

Figure 9 presents the nitrate concentration measured at different hydraulic retention times in the aerobic biological process, during different climate temperatures. At a climate temperature of 24°C, the initial concentration was 6 mg/L, and the final concentration was 12 mg/L, which shows a 6 mg/L nitrate accumulation in the aerobic biological process. At a climate temperature of 18°C, the initial concentration was 3 mg/L, and the final concentration was 4 mg/L, which shows a 1 mg/L nitrate accumulation. The difference between 24°C and 18°C climate temperatures on nitrate accumulation was 11 mg/L, which amounts to a 91.7% difference. The results show that as the global climate temperatures rise in surface waters, there is no benefit in the aerobic biological process of nitrate accumulation. The same was observed at the climate temperatures of 20°C and 22°C. The results show that the nitrate



accumulation at 18°C, 20°C, 22°C, and 24°C were 1 mg/L, 1 mg/L, 4 mg/L, and 6 mg/L, respectively. The percentage differences were 0%, 75%, and 33.3%, between climate temperatures 18°C and 20°C, 20°C and 22°C, and 22°C and 24°C, respectively. The accumulation of nitrate in the aerobic biological process is a result of the nitrification process, where ammonia is converted into nitrite and nitrate.

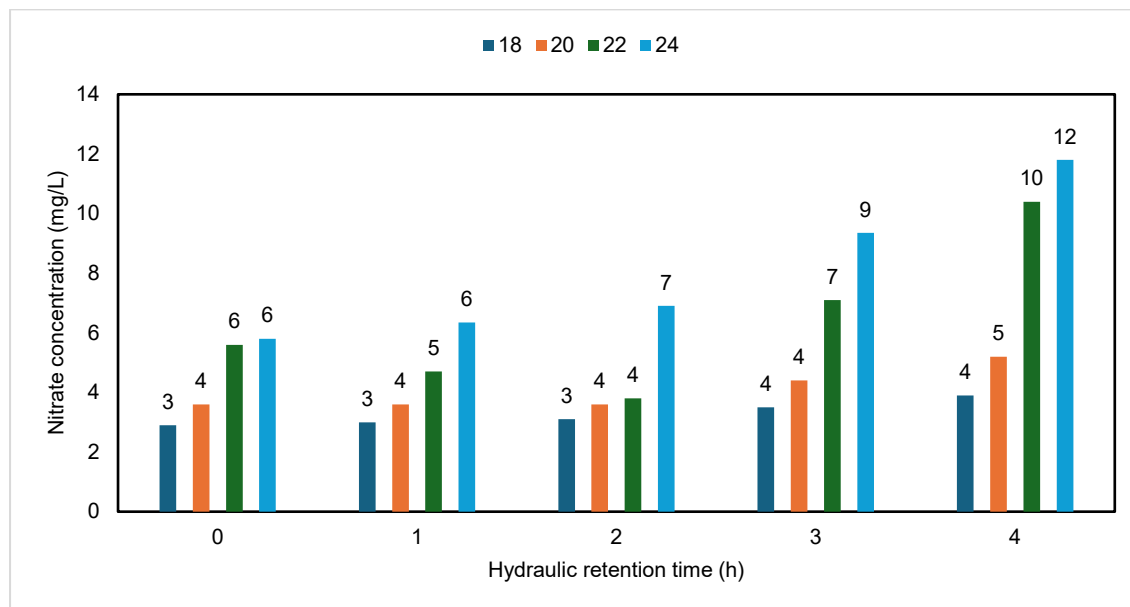


Figure 10: Nitrate accumulation measured at different hydraulic retention times in the aerobic biological process

Figure 10 presents nitrate accumulation measured at different energy consumption levels in the aerobic biological process, during different climate temperatures. The results indicate that higher climate temperatures increased nitrate accumulation per energy consumed compared to lower climate temperatures. At 0.02175 kWh energy consumption, nitrate accumulation was 1 mg/L, 2 mg/L, 5 mg/L, and 6 mg/L, measured at climate temperatures of 18°C, 20°C, 22°C, and 24°C, respectively. This was a difference of 50%, 60%, and 16.7% between climate temperatures 18°C and 20°C, 20°C and 22°C, and 22°C and 24°C, respectively. The results obtained at 0.0435 kWh energy consumption were similar to the results obtained at 0.02175 kWh. The nitrate accumulation was 1 mg/L, 2 mg/L, 6 mg/L, and 5 mg/L, measured at climate temperatures of 18°C, 20°C, 22°C, and 24°C, respectively. This was a difference of 50%, 66.7%, and 16.7% (negative) between climate temperatures 18°C and 20°C, 20°C and 22°C, and 22°C and 24°C, respectively.

At 0.06525 kWh energy consumption, nitrate accumulation was 1 mg/L, 2 mg/L, 7 mg/L, and 5 mg/L, measured at climate temperatures of 18°C, 20°C, 22°C, and 24°C, respectively. This was a difference of 50%, 71.4%, and 28.6% (negative) between climate temperatures 18°C and 20°C, 20°C and 22°C, and 22°C and 24°C, respectively. Lastly, at 0.087 kWh energy consumption, nitrate accumulation was 0 mg/L, 1 mg/L, 3 mg/L, and 2 mg/L, measured at climate temperatures of 18°C, 20°C, 22°C, and 24°C, respectively. This was a difference of 100%, 66.7%, and 33.3% (negative) between climate temperatures 18°C and 20°C, 20°C and 22°C, and 22°C and 24°C, respectively. The overall nitrate accumulation at climate temperatures of 18°C, 20°C, 22°C, and 24°C were 0 mg/L, 1 mg/L, 3 mg/L, and 2 mg/L, at an



energy consumption of 0.087 kWh. Overall, rising climate temperatures have a negative effect on nitrate accumulation in the aerobic biological process.

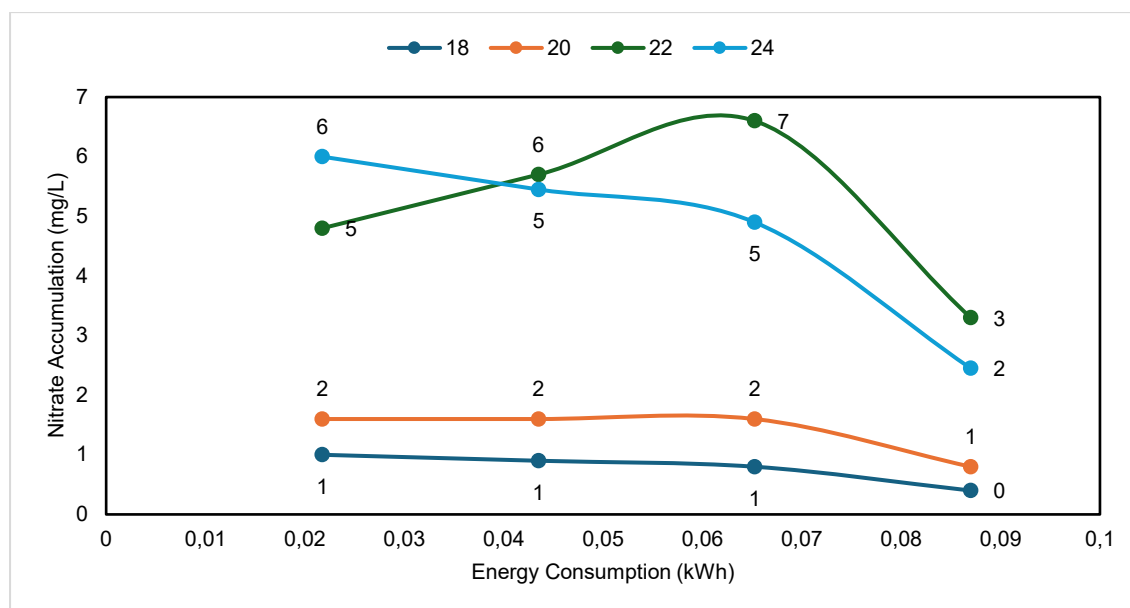


Figure 11: Nitrate accumulation measured at different energy consumption in the aerobic biological treatment process

Figure 11 presents energy consumed per ammonia removal at different hydraulic retention times, while Table 3 presents the percentage difference for energy consumed per ammonia removal difference for in the aerobic biological process. The energy consumed per ammonia removal was 0.01740 kWh/mg/L, 0.01740 kWh/mg/L, 0.01864 kWh/mg/L, 0.01933 kWh/mg/L for a climate temperature of 18°C. At a climate temperature of 20°C, energy consumed per ammonia removal was 0.01088 kWh/mg/L, 0.01088 kWh/mg/L, 0.01403 kWh/mg/L, and 0.01642 kWh/mg/L, at hydraulic retention times of 1, 2, 3, and 4 hours, respectively. Comparing climate temperatures of 18°C and 20°C, it shows that there is a 37.5%, 37.5%, 24.7%, and 15.1% energy saving as a result of a rise in climate temperatures.

At a climate temperature of 22°C, energy consumed per ammonia removal was 0.00737 kWh/mg/L, 0.00737 kWh/mg/L, 0.00953 kWh/mg/L, and 0.0115 kWh/mg/L at hydraulic retention times of 1, 2, 3, and 4 hours, respectively. Comparing climate temperatures of 20°C and 22°C, it shows that there is a 32.2%, 32.2%, 32.1%, and 32.1% energy saving as a result of a rise in climate temperatures. At a climate temperature of 24°C, energy consumed per ammonia removal was 0.00888 kWh/mg/L, 0.00888 kWh/mg/L, 0.00870 kWh/mg/L, and 0.00861 kWh/mg/L at hydraulic retention times of 1, 2, 3, and 4 hours, respectively. Comparing the climate temperatures of 24°C and 24°C, it shows that there is a 20.4%, 20.4%, 8.7%, and 22.8% energy saving as a result of a rise in climate temperatures. The overall energy consumption savings between 18°C and 24°C were 49%, 49%, 53.3%, and 55.4% at hydraulic retention times of 1, 2, 3, and 4 hours.

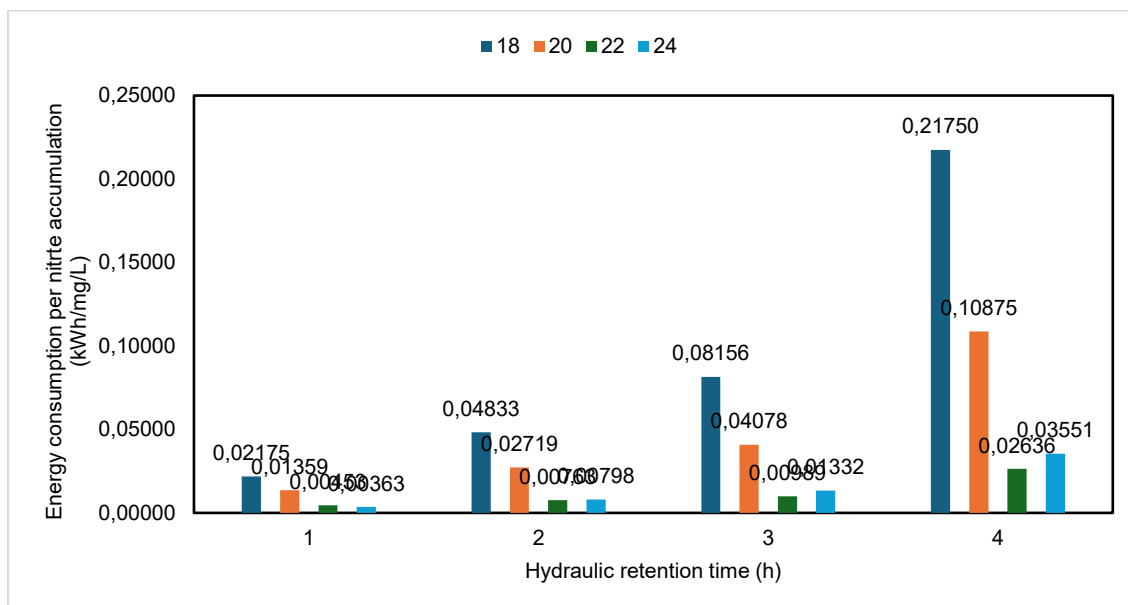


Figure 12: Energy consumed per nitrate accumulation at different hydraulic retention times

Table 4: Percentage difference between energy consumed

Energy consumption (kWh)	18°C – 20°C (%)	20°C – 22°C (%)	22°C – 24°C (%)	18°C – 24°C (%)
0.02175	37.5	66.7	20.0	83.3
0.0435	43.8	71.9	-4.6	83.5
0.06525	50.0	75.8	-34.7	83.7
0.087	50.0	75.8	-34.7	83.7

4.4 ANOVA test

Table 5 presents ANOVA test results on COD removal, ammonia removal, and nitrate accumulation energy consumption. The results show that climate temperatures had an impact on COD ($P = 0.000913$) and ammonia ($P = 0.0000012$) removal energy consumption. This supports the results obtained in sections 3.1 and 3.2 for COD and ammonia removal energy consumption. However, nitrate ANOVA test results were different, producing a P value of 0.13, which means that there was no difference in the nitrate accumulation energy consumed.

Table 5: ANOVA test results

Parameters	Temperature		
	F statistic	P value	F critical
COD removal energy consumption	36.75	0.000913	5.98
Ammonia removal energy consumption	379.11	0.0000012	5.98
Nitrate accumulation energy consumption	3.06	0.13	5.98

Conclusions and Future Research

The study aimed to analyze energy consumption at fluctuating hydraulic retention time in a climate-changing environment. Four climate temperatures were applied: 18°C, 20°C, 22°C,



and 24°C. The airflow rate was maintained at 5 litres per minute, while a four-hour hydraulic retention time was applied in the aerobic biological process. The results of the study showed that COD and ammonia removal increased, while nitrate accumulated with an increase in climate-rising temperatures. The energy consumed per mg/L COD removal was 0.00112 kWh/mg/L for a climate temperature of 18°C, while at a climate temperature of 24°C, energy consumed per COD removal was 0.00059 kWh/mg/L at hydraulic retention times of 4 hours, respectively. This was a difference of 47.3%, which shows that rising climate temperatures benefit the aerobic biological process. These results were supported by the ANOVA test results. Therefore, rising climate temperatures are beneficial in the aerobic biological process. Future work should commercialize this concept and produce a small packaged plant that can be commissioned in industry.



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Navigating Sustainability Claims and Greenwashing in South Africa's Insurance Industry: Industry Expert Perceptions

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Abstract

Background: The South African insurance industry has experienced a growing emphasis on sustainability and environmental, social, and governance (ESG) commitments in response to global climate imperatives, investor expectations, and regulatory developments. While this shift has created opportunities for responsible risk management and sustainable finance, it has also heightened concerns regarding greenwashing, where insurers may exaggerate or misrepresent their sustainability credentials. Such practices pose risks to stakeholder trust, governance integrity, and the credibility of ESG frameworks, particularly within emerging market contexts.

Purpose of the Study: The purpose of this study was to explore industry experts' perceptions of sustainability claims and greenwashing practices within the South African insurance industry. Rather than measuring the prevalence or financial impact of greenwashing, the study focused on understanding how experts interpret, experience, and evaluate sustainability communication and its implications for governance and accountability.

Methodology: The study adopted an interpretivist research philosophy and employed a qualitative, exploratory research design. Data were collected through semi-structured interviews with twelve industry experts, including insurance executives, sustainability and ESG professionals, regulatory specialists, and consultants. The interview data were analysed using thematic analysis to identify recurring patterns, meanings, and insights.

Key Findings: Four key themes emerged from the analysis: perceived superficiality and symbolic nature of sustainability claims; market, regulatory, and organisational drivers of greenwashing; implications for stakeholder trust, credibility, and governance; and the need for stronger regulatory, governance, and strategic responses.

Contribution: The study contributes to sustainability governance and greenwashing literature by providing context-specific, expert-led insights from the South African insurance sector. Practically, the findings inform insurers, regulators, and ESG practitioners seeking to enhance transparency, accountability, and the credibility of sustainability practices.

Keywords: ESG; greenwashing; insurance industry; sustainability governance; stakeholder trust

JEL Codes: G22; Q56; M14



1. Introduction

The integration of Environmental, Social, and Governance (ESG) principles into the insurance sector has achieved significant momentum worldwide, especially in emerging markets such as South Africa. This increasing focus on sustainability signifies wider societal transitions towards responsible corporate conduct and has implications for how insurance companies' function, promote themselves, and interact with stakeholders. Recent research suggests that environmental, social, and governance (ESG) initiatives contribute to the stability and long-term sustainability of insurance providers. For example, Chiaramonte *et al.* (2020) illustrate that sustainability initiatives exert a favourable influence on business stability within the insurance industry, given the growing emphasis placed on environmental, social, and governance (ESG) performance by institutional investors and stakeholders. Furthermore, Huang and Lin (2023) examine how green financing initiatives, underpinned by regulatory frameworks, can improve the resilience of the insurance market, thereby emphasising the significance of sustainable practices.

The international movement towards integrating sustainability into fundamental business strategies has likewise impacted the South African landscape, where insurance firms are increasingly required to implement comparable measures in compliance with regulatory requirements and evolving consumer demands. Eling (2024) emphasizes the imperative for a holistic strategy towards sustainability that integrates economic, environmental, and social facets in order to proficiently address stakeholder expectations (Eling, 2024). In South Africa, where challenges such as climate change present significant threats to insurance activities, the implementation of strong ESG commitments is both advisable and essential. In recent years, insurance companies have progressively integrated sustainability claims into their corporate branding and stakeholder communication strategies.

This transition is demonstrated by the increasing emphasis on sustainability reporting and stakeholder engagement, which have become essential components of business practices. For instance, Ahn and Park (2023) provide an example of how prominent organisations, such as Kyobo Life Insurance in South Korea, successfully disseminate information regarding their corporate social responsibility initiatives, thereby illustrating the advantages of transparent stakeholder communication in cultivating a favourable perception of sustainability.

Nevertheless, the corporate sustainability landscape is not without its difficulties. The practice of greenwashing, wherein organisations disseminate deceptive information regarding their environmentally conscious operations, has become a significant issue. Research conducted by Nemes *et al.* (2022) offers a comprehensive framework for evaluating greenwashing, highlighting diverse deceptive strategies utilised by companies to exaggerate their environmental commitments (Nemes *et al.*, 2022). This issue is especially pertinent within the South African insurance sector, where companies might be inclined to overstate their sustainability efforts in order to fulfil societal expectations without substantial evidence. The perception of sustainability claims by consumers is a critical factor influencing the effectiveness of corporate branding.

Research indicates that consumers are increasingly discerning regarding environmentally focused marketing strategies. For example, the study conducted by Wu *et al.* (2025) demonstrates that negative perceptions of greenwashing can result in heightened scepticism



regarding sustainability claims throughout an entire industry sector (Wu *et al.*, 2025). This scepticism can substantially influence consumer behaviour, ultimately influencing purchasing decisions and brand loyalty within the insurance industry. Therefore, transparent and genuine communication of sustainability practices is essential for preserving trust and engagement with stakeholders (Szabo & Webster, 2020). Furthermore, as highlighted by Guerreiro and Pacheco (2021) successful stakeholder engagement is critical for cultivating consumer trust and promoting favourable brand perceptions (Guerreiro *et al.*, 2021). The insurance industry must carefully manage the equilibrium between authentic sustainability initiatives and the risks associated with greenwashing to foster a customer base that values transparent corporate conduct.

Greenwashing constitutes a deliberate strategy employed by organisations to portray an environmentally responsible image to stakeholders without engaging in genuine sustainable practices. It is frequently characterised by deceptive marketing strategies, where the true environmental impact of products or services fails to correspond with the claims asserted (Kahraman & Kazançoğlu, 2019). Research indicates that stakeholders frequently encounter misleading communications concerning Environmental, Social, and Governance (ESG) criteria, resulting in distorted perceptions of a company's environmental performance (Zahid *et al.*, 2023). In an environment characterised by heightened scrutiny of corporate sustainability practices, such deceptive communications can lead to reputational harm and a decline in consumer confidence (Dempere *et al.*, 2024).

Research suggests that greenwashing may take several forms, including unsubstantiated claims regarding product environmental qualities and the development of ESG disclosures that lack rigorous validation (Yu *et al.*, 2020; Holloway, 2024). This phenomenon is especially concerning in sectors such as the insurance industry, where regulatory frameworks may lack the rigour necessary to effectively prevent deceptive practices. The representation of investment products as environmentally sound, absent adherence to recognised environmental benchmarks, constructs a deceptive impression of corporate accountability, potentially misinforming both investors and consumers (Szabo *et al.*, 2020). A significant element of greenwashing is its potential influence on investment choices. Unreliable ESG data may obstruct the integration of sustainability considerations into investment decision-making, thereby designating firms involved in greenwashing as untrustworthy partners for socially conscious investors (Yu *et al.*, 2020). Stakeholders are progressively requiring transparent and credible disclosures concerning ESG initiatives and failing to meet these expectations may result in substantial financial consequences for organisations engaged in greenwashing (Cosma *et al.*, 2023; Ayele & Singh, 2024).

The consequences of greenwashing extend beyond misleading consumers and can impact wider financial systems. It has been documented that deceptive sustainability narratives can hinder the development of authentic sustainable finance, which is essential for tackling global environmental challenges (Bengo *et al.*, 2022; Rosa, 2025). Investors pursuing responsible investment opportunities may experience disillusionment, leading to increased scepticism towards financial products designated as "green," thereby obstructing initiatives aimed at transitioning to sustainable economic frameworks (David *et al.*, 2024).

Within South Africa's financial services sector, greenwashing presents a significant hurdle as the market endeavours to comply with evolving sustainability regulations and frameworks. Stakeholders, encompassing regulatory bodies, are required to operate within a



multidimensional environment. The integration of sustainability considerations into the overarching regulatory framework has been initiated through directives such as the EU Sustainable Finance Disclosure Regulation; nevertheless, the effective implementation and enforcement of these regulations in emerging markets continue to be essential in addressing practices that undermine sustainability (Pacelli *et al.*, 2022; Rosa, 2025). The King IV reporting framework further demonstrates South Africa's dedication to strong corporate governance and stakeholder engagement; however, the alignment between corporate sustainability strategies and market expectations continues to be a significant challenge that must be addressed (Nel & Spuy, 2021; Wang *et al.*, 2022). To address the issue of greenwashing, stakeholders within the financial and insurance services sectors must promote greater transparency and accountability. The implementation of improved verification protocols for ESG disclosures would likely promote a more reliable depiction of an organization's sustainability initiatives (Misrofinhah *et al.*, 2024).

Furthermore, financial institutions are required to develop consumer education programs that effectively inform stakeholders about the standards used to assess green claims (Pizzetti *et al.*, 2019). Environmental regulations should prioritise the provision of explicit guidelines for environmental marketing and the implementation of sanctions for deceptive claims, thus cultivating a climate of transparency (Msomi *et al.*, 2025). Furthermore, the development of collaborative governance frameworks that include stakeholders from the corporate sector, media, and regulatory agencies may contribute to establishing a more comprehensive approach to addressing greenwashing (Vorster & Nwosu, 2024). This integrated approach may augment the efficacy of existing policies designed to promote accurate depictions of environmental endeavours and could proactively involve consumers in climate-focused investment choices (Beloskar *et al.*, 2023).

The problem addressed in this study is the growing ambiguity and potential misrepresentation of sustainability claims within South Africa's insurance industry, which has heightened concerns around greenwashing and weakened stakeholder trust. The growing emphasis on sustainability and ESG principles within South Africa's insurance sector has generated both positive momentum and notable apprehension, leading to the issue examined in this study. On the positive side, insurers are progressively aligning their strategies with principles of sustainable development, climate risk management, and responsible investment practices, in response to increasing regulatory demands and stakeholder expectations. However, this has been accompanied by an increasing risk of greenwashing, whereby sustainability claims may be overstated, ambiguous, or deceptive, thereby eroding trust and accountability within the sector. A current challenge is the insufficient comprehension of how these practices are viewed and understood by industry professionals specialising in strategy, regulation, and ethical governance. The issue thus highlights a distinct necessity for a qualitative, perception-oriented investigation to confront both practical governance issues and theoretical voids in the greenwashing literature within the financial services sector. Given the expanding scope of sustainability reporting within the insurance industry, the extent of the issue is considerable, with implications for consumer confidence, regulatory integrity, and the long-term resilience of the sector. This study closely corresponds with South Africa's National Development Plan, regional sustainability objectives, and international initiatives such as the Sustainable Development Goals and climate-related financial disclosure frameworks, all of which emphasise the importance of transparency, ethical standards, and sustainable economic growth.



The research aim for this study is to explore industry experts' perceptions of sustainability claims and greenwashing practices within the South African insurance industry and the research objective is to explore and understand industry experts' perceptions of sustainability claims and greenwashing practices within the South African insurance industry. This study contributes to the existing body of literature on sustainability, environmental, social, and governance (ESG) factors, and greenwashing within the financial and insurance sectors. It offers context-specific, qualitative perspectives derived from industry experts in South Africa. This study addresses a significant deficiency in the current literature, which has primarily concentrated on non-financial sectors, by enhancing the theoretical comprehension of how sustainability claims are interpreted and legitimised within insurance markets. The study's conclusions hold practical significance for insurers, regulatory bodies, policymakers, and sustainability professionals aiming to improve transparency, credibility, and ethical communication within sustainability reporting frameworks. This research further contributes to the formulation of robust governance frameworks and regulatory supervision procedures by elucidating expert viewpoints on accountability and risk management. This approach encourages more accountable sustainability practices, consistent with national development priorities and international ESG and sustainability initiatives.

This paper is organised to offer a systematic and coherent analysis of sustainability assertions and greenwashing within South Africa's insurance sector. The introduction of the paper provides an overview of the study's history, problem statement, research goal, and importance. This is succeeded by a literature review that consolidates extant research on sustainability, ESG practices, greenwashing, and pertinent theoretical frameworks. The methodology section subsequently details the qualitative research design, sampling strategy, data acquisition methods, and analysis procedures. The findings section delineates the principal themes arising from industry expert insights, which are subsequently analysed in relation to existing literature and theoretical frameworks. The paper concludes with a synthesis of the principal findings, their implications, the identified limitations, and suggested directions for future research.

2. Literature Review

2.1 Sustainability and ESG in the Insurance Industry

Through their fundamental business practices and risk management techniques, insurers naturally support sustainable development. Chiaramonte *et al.* (2020) emphasise the significance of adopting a stakeholder-centric perspective in strengthening stability across diverse insurance functions, such as product development and claims management, thereby enabling insurers to respond more effectively to societal requirements (Chiaramonte *et al.*, 2020). The implementation of sustainable insurance practices has been associated with improved financial stability, benefiting both insurers and their clients while encouraging greater economic resilience (Barabanova, 2023). Furthermore, regulatory initiatives, including the Task Force on Climate-related Financial Disclosures (TCFD), require insurers to disclose their climate-related risks and actively address related vulnerabilities (Luiz, 2024). This transition not only improves transparency but also ensures that insurance practices conform to international sustainability standards. Brogi *et al.* (2022) emphasise the importance of frameworks like the Principles for Sustainable Insurance (PSI), which advocate for insurers to incorporate ESG factors into their business strategy and risk evaluations (Brogi *et al.*, 2022). The Principles for Sustainable Insurance (PSI) framework has achieved broad adoption within



the insurance industry for the purpose of improving environmental and social responsibility (Brogi *et al.*, 2022).

In South Africa, the incorporation of sustainable practices within the insurance sector is essential owing to the nation's considerable susceptibility to the effects of climate change. The implementation of environmentally sustainable practices, such as participation in renewable energy initiatives, positions insurers as integral contributors to the transition towards a more sustainable economy (Samour *et al.*, 2022). Through the endorsement of such initiatives, insurance enterprises can attenuate environmental hazards whilst simultaneously promoting economic development. The integration of ESG criteria into insurance products and underwriting procedures is increasingly prevalent as insurers recognise the long-term advantages of aligning with sustainability principles. Eling (2024) contends that a comprehensive sustainability framework encompassing economic and technological aspects is essential for the insurance industry to flourish in a progressively environmentally conscious market (Eling, 2024). This framework promotes that insurer assess not only conventional financial risks but also the socio-environmental consequences of their underwriting policies.

Furthermore, actuarial professionals are progressively entrusted with evaluating the sustainability of investment projects, thereby strengthening the financial stability of green initiatives. The responsibilities of actuaries encompass the development of financing strategies that promote sustainable development and the optimisation of resource distribution to improve the returns of investments in ESG-compliant initiatives (Wang'ombe, 2024). These proactive initiatives support the overarching Sustainable Development Goals (SDGs), underscoring the significance of insurance within sustainable infrastructure development and societal advancement (Wang'ombe, 2024). Nonetheless, the adoption of ESG principles presents several challenges. The incidence of greenwashing, wherein organisations overstate their sustainability endeavours to improve their public perception, presents a considerable threat to the integrity of authentic sustainability programs within the insurance industry. As highlighted by Daugaard and Ding (2022) consumer scepticism and regulatory oversight concerning sustainability claims require comprehensive frameworks to mitigate the risk of deceptive representations (Daugaard *et al.*, 2022). Insurance providers are required to address these intricacies by improving their reporting methodologies and maintaining transparency within their sustainability communications (Khovrak, 2020).

2.2 Sustainability Claims and Corporate Communication

Sustainability disclosures function as essential communications between organisations and stakeholders, intended to promote transparency concerning corporate practices across environmental, social, and governance (ESG) dimensions. The legitimacy theory asserts that organisations disclose sustainability information to validate their activities to stakeholders and uphold their legitimacy within society (Mohammed *et al.*, 2024). In the South African context, governmental frameworks such as the King Reports have strengthened corporate governance and sustainability reporting, requiring organisations to produce integrated reports that address both financial and non-financial performance aspects (Mans-Kemp & Cornelis, 2020). However, existing research suggests that the quality and usefulness of sustainability disclosures frequently differ, implying that numerous companies may regard these reports as superficial compliance measures rather than instruments for strategic stakeholder engagement (Marti *et al.*, 2025). Furthermore, aligning corporate sustainability initiatives with wider societal objectives is essential. As Bezuidenhout and Kloppers (2023) contend,



communication regarding corporate social responsibility (CSR) in developing nations such as South Africa can be structured to promote both corporate prosperity and societal well-being (Bezuidenhout *et al.*, 2023). This dichotomy emphasises the significance of positioning sustainability narratives not solely as marketing instruments, but as authentic pledges that align with stakeholder values.

Within the insurance sector, sustainability narratives are progressively regarded as strategic assets capable of strengthening corporate reputation and encouraging stakeholder trust. The integration of sustainability practices necessitates a thorough comprehension of the insurance value chain, proposing that insurers structure their sustainability initiatives around product development, risk management, and claims procedures (Barrera & Wagner, 2023). This strategic application of narratives transcends mere regulatory adherence, extending into domains where corporate identity and stakeholder engagement are intrinsically linked with sustainability initiatives. Furthermore, the increasing scrutiny of greenwashing, where companies overstate their environmental commitments or deceive stakeholders regarding their sustainability efforts, illustrates the challenges insurers encounter in effectively conveying their ESG commitments (Kapoor *et al.*, 2021).

However, the efficiency of such communication mostly depends on the emotional appeal and authenticity of the message. This complexity emphasises the necessity for insurers to implement comprehensive communication strategies that encompass environmental, social, and governance factors, avoiding undue emphasis on any single area to the detriment of others (Routray, 2024). Furthermore, regulatory frameworks that mandate standardised sustainability reporting mitigate the risks associated with greenwashing. The literature supports the implementation of independent third-party audits to verify sustainability assertions and strengthen corporate accountability (Tin & Yong, 2025). Consequently, effective environmental, social, and governance (ESG) communication within the insurance sector requires the implementation of frameworks that ensure adherence to regulatory mandates while concurrently encouraging substantive engagement with stakeholders regarding sustainability goals (Stricker *et al.*, 2022).

2.3 Regulatory and Ethical Considerations

South Africa's regulatory framework concerning sustainability claims is governed by various principal laws and guidelines. The Companies and Allied Matters Act and the Securities and Exchange Commission's Sustainability Disclosure Guidelines underscore the importance of transparency and accountability in corporate disclosures (Yurieva & Shevchenko, 2024). Codes of good practice and guidelines issued by the Department of Environmental Affairs further require that companies, including entities within the insurance sector, disclose their environmental impacts and sustainability initiatives (Yulianti, 2025). Furthermore, the obligation to uphold ethical standards is emphasised within the industry through frameworks that promote fiduciary responsibility and a culture of compliance, as demonstrated by the work of Ogedengbe *et al.* (2024) who emphasise the vital importance of ethical conduct in encouraging trust within the insurance marketplace (Ogedengbe *et al.*, 2024).

The standards established by the Global Reporting Initiative (GRI) and the Sustainability Accounting Standards Board (SASB) serve as essential frameworks in directing corporate sustainability reporting, guaranteeing that disclosures are thorough and pertinent to diverse stakeholders (Yurieva *et al.*, 2024). These frameworks assist in reducing risks associated with



misleading sustainability assertions and ensure organisations are held accountable to their stakeholders. Greenwashing, the deceptive practice of misrepresenting the environmental advantages of a product, service, or company, presents significant ethical challenges and the potential for reputational damage to organisations within the insurance industry. As public awareness regarding sustainability concerns advances, corporations are subject to heightened scrutiny concerning their assertions. Greenwashing practices have the potential to erode consumer confidence, thereby leading to substantial financial consequences (Angmalisang, 2025). Ethical frameworks, as articulated by Gesser *et al.* (2024) are essential for mitigating these reputational risks, encouraging integrity in corporate conduct, and ensuring regulatory adherence (Gesser *et al.*, 2024).

Furthermore, the ethical considerations go beyond individual consumer concerns; they involve wider societal effects, including matters related to environmental justice and social inequality (Kelling *et al.*, 2020). Insurers involved in greenwashing may ultimately face regulatory investigation, sanctions, and a diminution of their credibility within the marketplace. Sustainability disclosures are fundamentally designed to furnish stakeholders, including clients, investors, and regulatory bodies, with a transparent assessment of an organization's environmental, social, and governance performance. These disclosures fulfil several objectives: augmenting transparency, informing investment choices, and encouraging accountability (Yulianti, 2025). They also enable firms to distinguish themselves within a competitive marketplace, thereby reinforcing their dedication to sustainable practices and corporate social responsibility (Yulianti, 2025).

Strategic sustainability narratives within the insurance industry can facilitate the development of stronger relationships with consumers and improve brand loyalty. According to Bakare *et al.*, the incorporation of ethical principles and legal requirements cultivates a culture of accountability and trust, which is essential for protecting stakeholder interests and bolstering enduring brand reputation (Bakare *et al.*, 2024). The insurance industry's strategic utilisation of sustainability narratives can function as a potent instrument for differentiation within a competitive marketplace. Through genuine articulation of their sustainability initiatives, insurers can not only comply with regulatory mandates but also establish a meaningful connection with the progressively environmentally aware consumer base (Ogedengbe *et al.*, 2024). However, it is essential that these narratives are anchored in demonstrable actions and genuine commitments to sustainability; otherwise, insurers may face the negative consequences of greenwashing.

2.4 Theoretical Lens

Stakeholder Theory offers a suitable and comprehensive theoretical framework for this study, as it emphasises the obligations of organisations to a wide array of stakeholders beyond shareholders, including policyholders, regulators, investors, employees, communities, and society as a whole. In the South African insurance sector, sustainability assertions and ESG disclosures significantly influence stakeholder views, trust, and legitimacy. This study employs Stakeholder Theory to analyse how greenwashing practices may develop when insurers prioritise reputational or commercial objectives over transparent and accountable communication with stakeholders. Through an examination of industry expert perspectives, this study elucidates how deceptive or unclear sustainability communications can erode stakeholder trust, diminish confidence in the insurance industry, and impede the generation of enduring value. Stakeholder Theory thus facilitates a more comprehensive understanding of



the ethical and governance considerations associated with sustainability communication, emphasising the importance for insurers to reconcile conflicting stakeholder expectations while maintaining credible, responsible, and transparent sustainability practices that align with societal and developmental objectives.

2.4 Research Gap

Despite the increasing volume of literature on sustainability reporting and greenwashing, a significant void persists in qualitative, perception-based research that concentrates specifically on industry experts within South Africa's insurance industry. Existing research has primarily employed quantitative methods or focused on consumer perceptions and corporate disclosures, providing limited understanding of how greenwashing is comprehended, interpreted, and managed by professionals engaged in strategic, regulatory, and sustainability decision-making. Furthermore, the South African insurance landscape, influenced by distinctive regulatory, socio-economic, and developmental factors, remains insufficiently examined within greenwashing research. The absence of context-specific, expert-led research limits both the theoretical progress and the practical comprehension of sustainability communication within the financial services sector. Therefore, a discernible requirement exists for qualitative, in-depth investigation that incorporates the viewpoints of industry experts to elucidate the practical manifestations of greenwashing, the rationales employed, or critiques levelled against it, and potential remediation strategies involving improved governance, ethical communication, and regulatory supervision.

3. Research Methodology

3.1 Research Philosophy and Approach

The study is based on an interpretivist paradigm, which is suitable for exploring the subjective meanings, interpretations, and experiences related to sustainability claims and greenwashing in the South African insurance sector. Interpretivism acknowledges that reality is socially constructed and that comprehending complex organisational phenomena requires engagement with the perspectives of those directly involved. Accordingly, the study employs a qualitative, exploratory research methodology to obtain comprehensive, in-depth insights into how industry professionals perceive, interpret, and manage sustainability communication and greenwashing practices in practice. Instead of attempting to quantify the degree of greenwashing or to evaluate predefined hypotheses, the exploratory approach facilitates adaptability and receptiveness to emerging themes rooted in expert insights. This approach is especially appropriate considering the limited empirical research on greenwashing within the South African insurance sector and contributes to the development of context-specific knowledge that advances theoretical comprehension and guides practical governance and regulatory measures.

3.2 Research Design

This study employs an expert-based qualitative research approach, which is well adapted for investigating complex and sensitive topics such as sustainability claims and greenwashing within the South African insurance sector. Industry experts possess specialised knowledge, strategic insight, and regulatory awareness that allow them to critically evaluate sustainability practices beyond superficial disclosures. The selection of a qualitative research design, with an emphasis on perceptual understanding, is warranted because the study aimed to elucidate



the interpretation, experience, and practical navigation of greenwashing, rather than to quantify its incidence or establish causal connections. Greenwashing is inherently context-dependent and frequently integrated into organisational narratives, governance frameworks, and regulatory settings, which renders it challenging to detect solely through quantitative approaches. Through the utilisation of comprehensive, semi-structured interviews with specialists, the study enables the examination of understated perspectives, ethical issues, and sector-specific factors. This design thus facilitates the creation of comprehensive, interpretive data that supports both theoretical advancement and practical insights pertinent to sustainability governance and ethical communication within the insurance industry.

3.3 Study Context

This study is focused on the South African insurance industry, a significant element of the nation's financial sector, which is essential for risk mitigation, investment activities, and overall economic stability. The sector functions within a landscape increasingly influenced by sustainability demands, climate-related hazards, and expanding requirements for transparent environmental, social, and governance methodologies. South African insurers face the imperative of aligning with international sustainability frameworks and national development objectives, while simultaneously upholding competitiveness and regulatory adherence.

The regulatory and market landscape is defined by progressive governance frameworks, encompassing conduct regulation, ESG disclosure standards, and voluntary sustainability reporting initiatives. Although these frameworks promote responsible business practices, deficiencies in enforcement and standardisation may foster environments conducive to greenwashing. This context establishes a pertinent and evolving framework for investigating industry experts' perspectives on sustainability claims and greenwashing behaviours within the South African insurance sector.

3.4 Sampling Strategy

The target population for this study consists of insurance industry professionals in South Africa, encompassing senior executives, sustainability and ESG officers, regulatory specialists, and industry consultants with direct expertise in sustainability practices and governance. A purposive sampling method was utilised to select participants with pertinent expertise and experience concerning sustainability claims and greenwashing. This approach was supplemented by snowball sampling, which enabled initial participants to identify additional knowledgeable experts within the sector. Inclusion criteria mandated that participants possess extensive professional experience within the South African insurance sector and demonstrate active engagement in sustainability, compliance, or strategic decision-making. Participants lacking direct industry specialisation or pertinent sustainability experience were omitted from the research.

3.5 Data Collection

Data for this study were gathered through semi-structured interviews with a sample of insurance industry professionals in South Africa, comprising senior executives, sustainability and ESG officers, regulatory experts, and industry consultants. These individuals were chosen because of their direct engagement in sustainability reporting, governance, compliance, and strategic decision-making within the insurance industry. An interview guide was methodically crafted based on the research objective and pertinent literature to ensure coherence and



consistency, while maintaining flexibility to thoroughly investigate emerging issues. Interviews were carried out until data saturation was achieved following twelve (12) expert interviews, at which point no additional themes or significant insights arose from the data. Reaching saturation at this stage affirmed the sufficiency of the sample size and strengthened the validity and profundity of the qualitative results.

3.6 Data Analysis

The data were examined employing a thematic analysis methodology, which is particularly appropriate for detecting, analysing, and interpreting patterns of significance within qualitative data. Interview recordings were transcribed verbatim and methodically analysed to produce insightful findings consistent with the study's objectives. The analysis employed a systematic coding procedure, commencing with open coding to identify initial concepts and recurring themes, followed by axial coding to establish connections between categories, and concluding with selective coding to refine and synthesise core themes. Through this iterative process, thematic patterns were derived inductively from the data. To strengthen rigour and facilitate efficient data management, qualitative data analysis software (NVivo) was employed to assist with coding, organisation, and retrieval of data, thereby enhancing analytical transparency and consistency.

3.7 Trustworthiness of the Study

The credibility of this qualitative investigation was established through the implementation of measures such as credibility, dependability, transferability, and confirmability. Credibility was strengthened through the involvement of experienced industry specialists and the execution of comprehensive, semi-structured interviews that facilitated detailed and genuine accounts of participant experiences, corroborated by data saturation. Reliability was ensured through a transparent and thoroughly documented research methodology, encompassing a readily accessible audit trail of data acquisition and analytical processes. Transferability was facilitated through comprehensive contextual descriptions of the South African insurance sector and participant profiles, allowing readers to evaluate the relevance of the findings to comparable settings. Confirmability was established through the practice of researcher reflexivity, the utilisation of verbatim transcripts, and the systematic documentation of analytical decisions, thereby minimising bias and ensuring that the findings were firmly rooted in the data.

3.8 Ethical Considerations

Ethical considerations were thoroughly examined throughout the study to guarantee the safeguarding of participants and the preservation of the research's integrity. Informed consent was secured from all participants before data collection, with each participant receiving a comprehensive information sheet detailing the study's goal, procedures, potential dangers, and their rights. Confidentiality and anonymity were preserved by anonymising participant identities and omitting any identifiable organisational information from transcripts and reports, with data securely stored and accessible solely to the researcher. Participation in the study was entirely voluntary, and participants were duly informed of their right to disengage at any point without facing any adverse consequences, thereby ensuring ethical adherence and respect for participant autonomy.

4. Findings



4.1 Participant Profile

Participant	Role / Position	Area of Expertise	Sector Exposure	Years of Experience
P1	Senior Executive	Strategic management and ESG integration	Insurance underwriting and corporate strategy	15+ years
P2	Sustainability Manager	ESG reporting and sustainability governance	Insurance and financial services	10–15 years
P3	Regulatory Specialist	Insurance regulation and compliance	Regulatory and oversight institutions	15+ years
P4	Industry Consultant	Sustainability advisory and risk management	Insurance and consulting	10–15 years
P5	Compliance Officer	Regulatory compliance and ethical governance	Insurance operations	10–15 years
P6	ESG Analyst	Sustainability metrics and disclosure frameworks	Insurance investments	5–10 years
P7	Senior Risk Manager	Climate and sustainability risk assessment	Insurance risk management	15+ years
P8	Policy Advisor	Financial sector policy and ESG regulation	Insurance and financial regulation	15+ years
P9	Sustainability Consultant	ESG strategy and reporting assurance	Insurance and advisory services	10–15 years
P10	Insurance Executive	Corporate governance and stakeholder engagement	Insurance leadership	15+ years
P11	Regulatory Consultant	Market conduct and compliance advisory	Insurance regulation	10–15 years
P12	ESG Governance Specialist	Sustainability governance and ethical communication	Insurance and financial services	10–15 years

4.2 Emergent Themes

This section outlines the primary themes that were identified through a thematic analysis of interviews conducted with industry experts within the South African insurance sector. The themes represent collective perceptions and experiences concerning sustainability claims, greenwashing practices, and their implications for governance, trust, and regulatory supervision within the industry.

4.2.1 Expert interpretations of sustainability claims in insurance



- ❖ *“Many sustainability claims in the insurance sector sound impressive on paper, but when you interrogate them, there is often very little substance behind what is being communicated.” (P1)*
- ❖ *“There is a growing tendency to use sustainability language as a branding tool rather than as a reflection of actual operational change, which creates a fine line between commitment and greenwashing.” (P3)*
- ❖ *“Greenwashing in insurance is not always deliberate deception; sometimes it stems from vague frameworks and unclear guidance on what genuinely qualifies as sustainable.” (P5)*
- ❖ *“I have observed that insurers often highlight isolated green initiatives while ignoring broader environmental impacts, which gives stakeholders a distorted picture.” (P7)*
- ❖ *“Sustainability claims are increasingly driven by market pressure and investor expectations, not necessarily by deep organisational transformation.” (P8)*
- ❖ *“There is a disconnect between sustainability messaging and what is actually implemented internally, especially when claims are not independently verified.” (P9)*
- ❖ *“From an industry perspective, greenwashing thrives where disclosures are voluntary and accountability mechanisms are weak.” (P10)*
- ❖ *“Experts within the industry can usually identify greenwashing quickly, but the average stakeholder may struggle to differentiate between genuine action and symbolic reporting.” (P12)*

Participants consistently viewed sustainability claims within the South African insurance industry as predominantly perfunctory and, in numerous instances, divorced from meaningful organisational practice. Multiple participants noted that sustainability narratives are often employed primarily as strategic communication or branding instruments rather than as genuine representations of substantive operational or environmental transformation. Participants further emphasized that greenwashing frequently arises not from intentional deceit but is rather facilitated by ambiguous ESG frameworks, voluntary disclosure practices, and inadequate accountability systems. Numerous participants noted that the selective disclosure of isolated green initiatives results in a skewed portrayal of insurers' overall environmental impact, thereby complicating stakeholders' ability to evaluate authenticity. These perceptions underscored an increasing concern that market, and investor pressures are accelerating sustainability messaging ahead of authentic transformation. The findings indicate that ambiguous sustainability communication and inadequate verification procedures substantially contribute to the continued prevalence of greenwashing, thereby compromising transparency and stakeholder confidence within the insurance industry.

4.2.2 Perceived forms and indicators of greenwashing

- ❖ *“Competitive pressure in the market pushes insurers to appear more sustainable than they actually are.” (P1)*
- ❖ *“Investor expectations play a major role, as companies feel compelled to demonstrate ESG alignment even when implementation is still limited.” (P2)*



- ❖ *“Weak regulatory enforcement creates an environment where firms can exaggerate sustainability claims without immediate consequences.” (P4)*
- ❖ *“There is pressure from global reporting frameworks, but not enough local guidance on how to apply them meaningfully.” (P5)*
- ❖ *“Marketing teams often lead sustainability communication, while operational teams struggle to keep pace.” (P6)*
- ❖ *“The lack of standardised ESG metrics allows organisations to selectively disclose information that presents them favourably.” (P8)*
- ❖ *“Greenwashing is sometimes driven by fear of reputational damage rather than a genuine commitment to sustainability.” (P10)*
- ❖ *“Without independent verification, sustainability reporting becomes more about perception management than real impact.” (P12)*

Participants consistently recognised a variety of interconnected factors that sustain greenwashing practices within the South African insurance sector. Multiple participants highlighted that intense market competition and increasing investor demands necessitate that insurers present strong sustainability credentials, frequently preceding full-scale execution. Participants also emphasised that insufficient regulatory enforcement and the lack of standardised ESG metrics generate opportunities for selective disclosures and inflated sustainability claims. Furthermore, participants observed that although global sustainability frameworks are influential, they are frequently inadequately tailored to local contexts, leading to inconsistent interpretation and reporting. Internal organisational dynamics were noted, as marketing imperatives often exceed operational capabilities to provide authentic sustainable objectives. Together, these factors were regarded as promoting symbolic adherence rather than meaningful transformation. Consequently, greenwashing was perceived not solely as an ethical breach, but as a systemic consequence of regulatory deficiencies, competitive dynamics, and misaligned organisational motivations within the insurance industry.

4.2.3 Drivers and motivations behind greenwashing practices

- ❖ *“When sustainability claims are exposed as exaggerated, it severely damages trust between insurers and their stakeholders.” (P1)*
- ❖ *“Greenwashing undermines the credibility of the entire insurance sector, not just the firms involved.” (P3)*
- ❖ *“Once trust is lost, it is extremely difficult for insurers to convince investors and policyholders of genuine sustainability efforts.” (P5)*
- ❖ *“Misleading ESG claims can result in reputational harm and increased regulatory scrutiny.” (P6)*
- ❖ *“Investors are becoming more sceptical of sustainability disclosures, especially when there is no independent verification.” (P7)*
- ❖ *“Greenwashing weakens governance structures by allowing symbolic compliance to replace meaningful accountability.” (P8)*



- ❖ *“The absence of strong oversight erodes confidence in both corporate disclosures and regulatory frameworks.” (P10)*
- ❖ *“Ultimately, greenwashing creates long-term risks for the industry by compromising credibility and stakeholder confidence.” (P12)*

Participants consistently emphasised that greenwashing practices pose substantial adverse effects on trust, credibility, and governance within the South African insurance sector. Several participants reported that stakeholder trust diminishes when sustainability claims are perceived as overstated or deceptive, thereby cultivating heightened scepticism towards ESG disclosures among policyholders and investors. Participants additionally observed that greenwashing not only impacts individual companies but also compromises the credibility of the entire insurance industry, resulting in reputational spill-over effects. Several participants highlighted that reduced trust hinders investor relations and could lead to increased regulatory scrutiny, thereby elevating compliance and governance risks. The findings further indicate that greenwashing undermines internal governance frameworks by permitting symbolic adherence to replace authentic accountability. Overall, participants regarded greenwashing as a prolonged threat to institutional legitimacy, with significant implications for stakeholder trust, regulatory efficiency, and the sustainability of the insurance sector.

4.2.4 Reputational, ethical, and regulatory risks

- ❖ *“Stronger regulatory frameworks are needed to clearly define what constitutes greenwashing in the insurance sector.” (P1)*
- ❖ *“Mandatory sustainability disclosures would reduce the opportunity for firms to selectively report favourable information.” (P3)*
- ❖ *“Independent verification of ESG claims would significantly improve credibility and accountability.” (P5)*
- ❖ *“Regulators need greater capacity and resources to effectively monitor sustainability claims.” (P6)*
- ❖ *“Clearer governance structures within organisations could prevent sustainability messaging from outpacing actual practice.” (P7)*
- ❖ *“Collaboration between regulators, insurers, and industry bodies is essential to address greenwashing consistently.” (P8)*
- ❖ *“Without enforcement and consequences, sustainability guidelines remain symbolic rather than effective.” (P10)*
- ❖ *“Improving stakeholder education would help policyholders and investors better assess the credibility of sustainability claims.” (P12)*

Participants consistently emphasised the necessity for improved regulatory, governance, and strategic measures to effectively combat greenwashing practices within the South African insurance sector. Numerous participants emphasised the necessity for more precise and effectively enforceable regulatory frameworks to delineate sustainability claims and prevent deceptive disclosures. Participants also emphasised that the implementation of mandatory reporting standards and the independent verification of ESG claims would substantially



improve transparency and accountability. Multiple participants emphasised the importance of enhancing internal governance, highlighting that aligning sustainability communication with operational procedures is essential to avoid superficial compliance. Collaboration among regulators, insurers, and industry organisations was regarded as vital for assuring the uniform implementation of sustainability standards. Furthermore, participants emphasised the importance of stakeholder education in empowering investors and policyholders to critically evaluate sustainability claims. Together, these insights suggest that combating greenwashing necessitates comprehensive regulatory reform, improved governance frameworks, and a strategic dedication to genuine sustainability practices.

4.3 Summary of Key Insights

This study's results present four interrelated insights regarding sustainability claims and greenwashing practices within the South African insurance sector. Theme One emphasises that sustainability assertions are often viewed as superficial and lacking a demonstrable link to significant operational modifications, frequently arising from symbolic communication rather than verifiable environmental outcomes. Theme Two highlights market competition, investor influence, inadequate regulatory enforcement, and the lack of standardised ESG metrics as primary factors facilitating greenwashing practices. Theme Three illustrates that greenwashing has substantial implications for stakeholder trust, institutional credibility, and governance, with reputational spill-over effects that extend beyond individual companies to the wider insurance industry. Theme Four emphasises the importance of establishing more robust regulatory frameworks, implementing obligatory disclosures, ensuring independent verification, enhancing internal governance, and promoting stakeholder education to effectively address greenwashing. Collectively, these themes demonstrate that greenwashing is a systemic problem necessitating coordinated regulatory, organisational, and strategic measures to re-establish transparency, accountability, and confidence in sustainability initiatives.

5. Discussion

5.1 Interpretation of Findings

The findings from this study offer a thorough comprehension of industry professionals' views regarding sustainability claims and greenwashing within the South African insurance sector, thereby directly fulfilling the research objective of investigating the practical understanding, experience, and management of greenwashing. The initial theme, which demonstrated that assertions of sustainability are frequently regarded as superficial and lacking substantive operational transformation, corresponds with the goal of analysing expert perspectives on sustainability communication and emphasises apprehensions concerning symbolic adherence. The second theme highlights market pressure, investor expectations, regulatory deficiencies, and organisational misalignment as primary catalysts of greenwashing, thereby broadening the comprehension of the contextual factors that facilitate such practices within the insurance industry. The third theme illustrates that greenwashing has extensive repercussions for stakeholder trust, institutional integrity, and governance, thereby advancing the goal of comprehending the wider implications of deceptive sustainability assertions. The fourth thematic area emphasises the necessity of robust regulatory frameworks, improved governance structures, and strategic interventions, thereby supporting the identification of pathways to mitigate greenwashing practices. The collective assessment of these themes



substantiates the conclusion that greenwashing within the South African insurance sector constitutes a systemic and multifaceted challenge. This emphasises the continued pertinence of stakeholder theory and emphasises the critical importance of transparent, accountable, and ethically driven sustainability practices.

5.2 Comparison with Existing Literature

The results of this study largely correspond with existing literature that recognises greenwashing as a result of inadequate regulatory supervision, voluntary ESG disclosures, and escalating stakeholder pressure within the financial services sector. As observed in previous research, these findings corroborate that sustainability claims are frequently employed symbolically to strengthen legitimacy, rather than to represent demonstrable environmental efficacy. The study also concurs with existing literature emphasising the decline in stakeholder trust and the reputational risks linked to deceptive ESG communication. However, the findings differ from certain previous studies by highlighting the complex role of industry experts, who regard greenwashing not solely as intentional deception but also because of ambiguous frameworks and organisational misalignment. This study expands upon the current body of research by providing context-specific perspectives from a developing market, thus contributing to the greenwashing discourse beyond extant consumer-centric or disclosure-oriented studies.

5.3 Theoretical Implications

This research contributes to the fields of sustainability governance and legitimacy theory by offering empirically based perspectives on the perceptions and interpretations of greenwashing practices within the South African insurance sector. The findings expand upon legitimacy theory by demonstrating how insurers utilise sustainability claims as symbolic tools to uphold social acceptability and stakeholder approval in the lack of substantive environmental advancements. Concurrently, this research contributes to the advancement of sustainability governance theory by elucidating the roles of regulatory deficiencies, voluntary disclosure frameworks, and inadequate accountability mechanisms in facilitating greenwashing activities. Through an emphasis on the perspectives of industry experts, this study illustrates the interplay between legitimacy-seeking actions and governance mechanisms at both organisational and institutional tiers. These insights improve theoretical understanding by framing greenwashing as a governance failure rather than merely an ethical shortcoming, thereby advancing scholarly discussions on legitimacy, accountability, and sustainability practices within the insurance sector and the wider financial services industry.

5.4 Practical Implications

The findings of this study provide several important practical implications for principal stakeholders within the South African insurance sector. For insurance companies, the findings emphasise the importance of progressing beyond superficial sustainability messaging and integrating ESG principles into fundamental operational and governance frameworks. Insurers are advised to synchronise sustainability communications with demonstrable actions, improve



internal governance measures, and promote transparency to reduce reputational and compliance risks related to greenwashing.

This study emphasises the critical need for regulators and policymakers to establish more transparent, rigorously enforced regulatory frameworks and standardised environmental, social, and governance (ESG) reporting mandates. Strengthened supervision, obligatory disclosures, and autonomous verification processes are crucial to prevent deceptive sustainability assertions and to safeguard the interests of stakeholders.

The study's conclusions emphasise the imperative for sustainability and ESG professionals to prioritise strong measurement methodologies, transparent reporting practices, and comprehensive stakeholder engagement initiatives. Practitioners are instrumental in connecting strategic planning with practical execution. They accomplish this by guaranteeing that sustainability initiatives are grounded in empirical evidence, readily auditable, and synchronised with organisational objectives as well as wider developmental targets.

6. Conclusion

This study aimed at exploring the perceptions of industry experts regarding sustainability claims and greenwashing practices within the South African insurance sector. The findings indicate that sustainability communication is often regarded as symbolic and, in certain instances, detached from meaningful operational transformation. Market competition, investor demands, regulatory deficiencies, and organisational incongruities were determined to be primary catalysts for greenwashing. The ramifications were observed to extend beyond individual corporations, encompassing the erosion of stakeholder trust, compromised governance, and reputational vulnerabilities for the wider insurance industry. Significantly, the research emphasises that greenwashing is frequently facilitated by voluntary disclosure mechanisms and unclear ESG frameworks, rather than solely by intentional misrepresentation.

This study contributes to the expanding academic discourse on sustainability governance and legitimacy theory by offering context-specific, qualitative insights derived from an emerging market. This study advances current greenwashing literature, which has primarily emphasised consumer perceptions or quantitative disclosure analyses, by prioritising expert viewpoints. The findings improve theoretical comprehension by framing greenwashing as a systemic challenge to governance and legitimacy within the insurance and financial services sectors. The study further emphasises the significance of expert-led insights in tackling greenwashing. Industry specialists hold a sophisticated comprehension of regulatory, strategic, and operational considerations, facilitating more thorough analysis of sustainability practices. Their perspectives are critical to the development of credible ESG frameworks and to closing the divide between sustainability discourse and substantive implementation.

Although it has made valuable contributions, the study is subject to certain limitations. Methodologically, the employment of a qualitative, exploratory approach and a comparatively small sample size restricts the generalisability of the results. Although data saturation was attained, the findings are interpretive in nature and do not aim to quantify the prevalence or extent of greenwashing practices within the industry. The study was conducted exclusively with industry experts within the South African insurance sector. Although this offered comprehensive and well-informed insights, it did not incorporate perspectives from other stakeholders such as policyholders, investors, and civil society actors, whose viewpoints may



vary. These limitations should be taken into account when analysing the results and extending their application to other sectors or geographical regions.

Practically, the study advises that insurance companies reinforce internal governance frameworks, synchronise sustainability communication with verifiable initiatives, and implement independent verification of ESG claims to improve transparency and credibility. Regulators and policymakers are urged to establish more precise and enforceable sustainability disclosure standards and to improve oversight mechanisms to effectively prevent greenwashing. For future research, scholars may expand upon this study by utilising quantitative or mixed methods approaches to investigate the prevalence and economic consequences of greenwashing in the insurance industry. Comparative analyses across regions or financial sub-sectors would improve comprehension further, while future qualitative research could integrate a wider range of stakeholder perspectives to deepen insights into sustainability accountability and trust.



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Exploring Grocery SME Owners' Perceptions of Shared Outsourced Transportation as a Strategy for Reducing Delivery Costs and Enhancing Competitiveness

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Abstract

Background: Grocery small and medium-sized enterprises (SMEs) operate in increasingly competitive and cost-sensitive retail environments where transportation and delivery costs represent a substantial portion of overall operating expenses. Rising fuel prices, frequent replenishment requirements, and limited economies of scale place sustained pressure on grocery SMEs, constraining their ability to compete effectively with larger retailers that possess more advanced logistics capabilities.

Purpose of the Study: The purpose of this study was to explore grocery SME owners' perceptions of shared outsourced transportation as a strategic response to delivery cost pressures and competitiveness challenges. Rather than measuring financial or operational outcomes, the study focused on understanding how decision-makers interpret, experience, and evaluate shared transportation arrangements within their business contexts.

Methodology: The study adopted an interpretivist research philosophy and employed a qualitative, exploratory research design. Data were collected through semi-structured interviews with twelve grocery SME owners and senior managers who were directly responsible for logistics and transportation decisions. The interview data were analysed using thematic analysis to identify recurring patterns and meanings.

Key Findings: Four key themes emerged from the analysis: perceived cost-saving benefits of shared outsourced transportation; enhanced operational flexibility and risk-sharing; challenges and concerns related to coordination, control, and service reliability; and the perceived influence of shared transportation on competitiveness and market positioning.

Contribution: The study contributes to SME logistics and transportation literature by offering qualitative, perception-based insights into shared outsourced transportation practices. Practically, the findings provide guidance for grocery SME owners, logistics service providers, and policymakers seeking to design and support collaborative transportation solutions that enhance SME cost efficiency and competitiveness.



Keywords: Competitiveness; grocery SMEs; shared outsourced transportation; SME logistics; Transportation cost management

JEL Codes: L26; L91; R41

1. Introduction

Transportation constitutes a critical element of supply chain management (SCM), particularly for grocery small and medium-sized enterprises (SMEs), where logistical efficacy can substantially influence cost structures and overall market competitiveness. As competition within the grocery industry becomes increasingly fierce, especially with the growth of e-commerce and globalisation, comprehending the significance of transportation is essential for SME owners seeking strategies such as shared outsourced transportation to lower delivery expenses and strengthen their market position.

Grocery small and medium-sized enterprises generally function with narrower profit margins in comparison to larger corporations. The primary components of their cost structure are logistics expenses, specifically transportation, warehousing, and inventory management. Transportation costs can represent a substantial component of overall operating expenses, especially during peak periods when demand increases and logistical resources are under increased pressure (Tianming *et al.*, 2019).

Within the evolving landscape of grocery retailing, the operation of internal transport fleets may engender elevated expenditures during periods of peak demand, concurrently fostering underutilisation during periods of diminished demand. This duality can contribute to logistical inefficiencies (Tianming *et al.*, 2019). By delegating transportation functions to third-party logistics (3PL) providers, small and medium-sized enterprises (SMEs) can alleviate these challenges. For example, a recent study demonstrated that small and medium-sized enterprises can achieve cost reductions of approximately 40% in transportation expenses through the effective utilisation of outsourced logistics, in addition to improvements in labour and warehousing costs (Zulkarnain, 2025).

Third-party logistics providers significantly contribute to the optimisation of transportation for small and medium-sized enterprises within the grocery sector. The incorporation of third-party logistics (3PL) services improves the scalability and responsiveness of logistical functions, thereby enabling small and medium-sized enterprises (SMEs) to accommodate fluctuating demands without the fixed expenditures related to owning and operating dedicated transportation fleets (Kgwadi & Samuels, 2025; Zulkarnain, 2025). Specifically, the capacity of 3PLs to rapidly expand operations enables SMEs to avoid the risks associated with excess capacity



during off-peak periods while ensuring they can accommodate abrupt surges in demand (Zulkarnain, 2025).

Furthermore, utilising third-party logistics (3PL) can improve stock availability by fostering more effectively managed supplier and customer relationships, which has been demonstrated to improve operational efficiency within the grocery industry (Monnagaaratwe & Mathu, 2022; Kgwadi *et al.*, 2025). The partnership between third-party logistics providers and small to medium-sized grocery enterprises not only reduces expenses but also has the potential to improve service quality, given that 3PLs frequently possess advanced technology and greater expertise in logistics management (Hatti & Karpagavalli, 2023; Bista *et al.*, 2025).

Outsourcing transport enables grocery SMEs to concentrate on their primary business activities while leveraging the logistical expertise offered by third-party logistics providers. This strategic transition has the potential to confer a competitive advantage by enabling cost efficiencies, enhancing service quality, and decreasing time to market. Through the adoption of sophisticated technologies and methodologies, including data analytics and demand forecasting, third-party logistics providers support grocery SMEs in enhancing their supply chain management, thereby directly influencing profitability and market positioning (Mangiaracina *et al.*, 2019; Zulkarnain, 2025).

Furthermore, the utilisation of third-party logistics providers fosters advancements in delivery methodologies, thereby improving the efficacy of last-mile delivery, which is a crucial determinant of customer contentment within the grocery retail sector (Mangiaracina *et al.*, 2019; Zulkarnain, 2025). Studies demonstrate that the adoption of third-party logistics (3PL) providers yields financial benefits and supports an organization's sustainability objectives by minimising carbon emissions through route optimisation and improved cargo utilisation (Tianming *et al.*, 2019; Zulkarnain, 2025).

A significant problem encountered by grocery SMEs in last-mile delivery is the rising consumer demand for swift and dependable delivery services. Alverhed *et al.* (2024) emphasise that operational restrictions and developing urban infrastructures can hinder efficient last-mile logistics, placing pressure on grocery SMEs that generally function with narrower margins than larger entities (Alverhed *et al.*, 2024). These SMEs frequently lack the requisite resources to adopt new logistics technology and may encounter difficulties in coordinating deliveries efficiently, leading to elevated operating expenses relative to their bigger counterparts (Han *et al.*, 2020; Mittal *et al.*, 2022).

The uncertainty caused by urban population development and traffic congestion intensifies the inefficiencies in last-mile logistics. Studies reveal that COVID-19 and the subsequent transition to e-commerce have necessitated rapid adaptation by SMEs; yet, numerous enterprises have institutional and physical obstacles that



constrain their logistics capacities (Švadlenka *et al.*, 2023). The infrastructure for efficient delivery frequently lacks support, compelling grocery SMEs to traverse intricate logistics without adequate assistance. To tackle these issues, some supermarket SMEs are progressively contemplating shared outsourced transportation as a feasible approach. The emergence of the shared economy, together with improvements in digital connectivity, offers SMEs a chance to lower logistics expenses while bolstering their competitiveness (Shanakar & Balaji, 2024). Through collaboration with 3PL and 4PL providers, supermarket SMEs can utilise established logistics networks, gaining advantages from the cost efficiencies these alliances present (Yahya, 2020).

The research examines many designs of last-mile logistics that may be advantageous for grocery SMEs. Hybrid systems provide participation from both vendors and customers in the logistics process, enhancing flexibility and reactivity (Odo *et al.*, 2024). This model assists SMEs in optimising expenses while fulfilling customer delivery time expectations. The incorporation of technology in shared logistics can improve operational transparency and optimise delivery procedures, which is essential for sustaining consumer happiness in the competitive e-commerce environment (Orji & U-Dominic, 2024). Collaborative transport systems enable grocery SMEs to pool resources, so alleviating the logistical challenges encountered by each SME, leading to reduced prices and improved service accessibility (Zennaro *et al.*, 2022). Implementing shared logistics methods necessitates careful consideration of variables like as reliability, cost reduction, and overall service quality, which can profoundly affect consumer perceptions (Raj & Thandayudhapani, 2024).

Small and medium-sized grocery enterprises (SMEs) continue to encounter enduring challenges related to delivery cost pressures, which undermine their operational efficiency and long-term competitiveness in increasingly price-sensitive and volatile markets.

Transportation expenditures, especially within the context of last-mile distribution, represent a substantial component of overall logistics expenses for grocery SMEs. These businesses frequently encounter challenges in securing cost-effective delivery solutions due to limitations in scale, infrastructure, and negotiating leverage. In response, shared outsourced transportation has arisen as a potentially effective approach to decrease delivery expenses and improve logistical efficiency. Nevertheless, despite its increasing significance, there is still limited qualitative understanding of how grocery SME proprietors perceive and experience the implementation of shared outsourced transportation arrangements. Existing research primarily employs quantitative or cost-focused methodologies, providing limited insight into the lived experiences, decision-making motivations, and contextual challenges encountered by SME proprietors. This deficiency in comprehensive, perception-based understanding restricts the formulation of contextually suitable logistics strategies and policy interventions aligned with the specific circumstances of grocery SMEs.



The study's aim is to explore grocery SME owners' perceptions of shared outsourced transportation as a strategy for reducing delivery costs and enhancing competitiveness. The research objective for this study is to explore grocery SME owners' perceptions of how shared outsourced transportation contributes to delivery cost efficiency and adds value in enhancing their competitiveness.

The significance for the study advances the literature on SME logistics and transportation by offering qualitative insights into the perceptions of grocery SME proprietors regarding shared outsourced transportation as a strategy for cost management and competitiveness. Practically, the findings provide practical guidance for SME owners, logistics service providers, and policymakers in developing collaborative, context-aware transportation solutions that improve efficiency, sustainability, and competitive advantage.

This paper is structured as follows, the initial section presents the research context, delineates the problem, outlines the objectives, and emphasises the significance of the study. The second section examines pertinent literature concerning grocery SMEs, transportation outsourcing, shared logistics, and competitiveness, and delineates the research gap. The third section delineates the qualitative research methodology, encompassing the research design, sampling approach, data acquisition methods, and analytical procedures. The fourth section delineates and examines the empirical data via emergent themes. The results are examined in the fifth section considering current theory and literature. The concluding section summarises the paper by emphasising key insights, acknowledging limitations, and outlining potential directions for future research.

2. Literature Review

2.1 Grocery SMEs and Transportation Cost Challenges

Grocery small and medium-sized enterprises frequently function within a fragile financial structure that constrains their capacity to efficiently control logistics expenses. Limited resources and inadequate market coverage impede their competitive ability (Oyeyemi *et al.*, 2023; Kgwadi *et al.*, 2025). Third-party logistics (3PL) integration has become a practical way to overcome these constraints. Through the utilisation of cost-effective outsourcing strategies, small and medium-sized enterprises (SMEs) can augment inventory management and operational effectiveness, consequently optimising service provision and decreasing lead times (Oyeyemi *et al.*, 2023; Kgwadi *et al.*, 2025).

Furthermore, the significance of collaboration within supply chains is vital for small and medium-sized grocery enterprises. These collaborative frameworks enable small and medium-sized enterprises to strategically engage with suppliers and logistics providers. Empirical evidence suggests that collaboration within the supply chain



improves the competitive advantage of FMCG small and medium-sized enterprises by facilitating resource sharing and reducing logistics expenses (Oyeyemi *et al.*, 2023). The implementation of efficient supply chain strategies can significantly reduce logistics expenditures for small and medium-sized enterprises, thereby enhancing their competitive positioning within the market.

One of the primary vulnerabilities confronting small and medium-sized grocery enterprises is their limited scale, which constrains their bargaining strength with transportation providers and suppliers (Alkaabi, 2023). Large corporations leverage economies of scale that enable lower transportation costs per unit, whereas small and medium-sized enterprises frequently face less advantageous terms, resulting in higher logistics expenses that may diminish profit margins (Rijal *et al.*, 2023).

Furthermore, inefficiencies in the integration of warehousing and transportation processes intensify these vulnerabilities. Inadequate coordination between warehouse activities and vehicle routing may result in avoidable delays and heightened costs within logistics operations (Rijal *et al.*, 2023). This situation emphasises the importance of efficient incorporation of logistics processes, which can be accomplished through strategic collaborations with third-party logistics providers capable of delivering essential infrastructure and technological support (Monnagaaratwe *et al.*, 2022).

Outsourcing transport logistics offers a viable approach to address these challenges effectively. Through collaborations with logistics service providers (LSPs), SMEs can leverage resources and expertise that would be prohibitively expensive to sustain internally (Kiggell *et al.*, 2021; Alkaabi, 2023). Research indicates that outsourcing logistics functions, when implemented effectively, can result in substantial long-term cost reductions, thereby reinforcing the potential for sustainable operational improvements (Kiggell *et al.*, 2021).

Strategic alliances with logistics partners can empower small and medium-sized enterprises to augment their service portfolios, thereby facilitating expedited delivery schedules and elevating customer contentment. This methodology not only contributes to the reduction of immediate delivery expenses but also enables small and medium-sized enterprises (SMEs) to exhibit greater adaptability in response to evolving market dynamics (Souza *et al.*, 2019). Furthermore, the deployment of shared transportation networks facilitates the optimisation of order fulfilment and distribution processes, potentially resulting in substantial cost efficiencies (Monnagaaratwe *et al.*, 2022).

2.2 Outsourced Transportation in SME Supply Chains

The outsourcing of conveyance functions enables small and medium-sized enterprises to capitalise on external expertise and resources, thereby potentially



improving service quality and operational efficiency. As asserted by Sadeghi *et al.* (2023), the efficacy of logistics management is paramount to the operational success of mobile grocery services, exerting a considerable influence on both delivery schedules and inventory control. When small and medium-sized enterprises (SMEs) collaborate with third-party logistics (3PL) providers, they gain access to established networks and technological infrastructures that would otherwise be expensive to develop independently (Monnagaaratwe *et al.*, 2022). This partnership may also improve supply chain resilience, a vital factor for organisations addressing post-pandemic challenges (Burgos & Ivanov, 2021). Furthermore, utilising shared transportation services can streamline operations, especially within fragmented supply chains where small and medium-sized enterprises encounter difficulties in scaling. Enhancing logistics via outsourcing facilitates strategic alignment of resources and capabilities, enabling small enterprises to contend with larger retailers in aspects of pricing and product availability (Monnagaaratwe *et al.*, 2022).

For SMEs in the grocery industry, outsourced transport has many benefits, chief among them being lower costs, better service, and a stronger emphasis on core skills. The cost savings achieved through outsourcing are derived from a shared economy framework in which small and medium-sized enterprises collaboratively utilise transportation resources, thereby decreasing their individual expenses related to logistics and distribution (Teixeira *et al.*, 2023). This approach has the potential to substantially reduce delivery expenses, as shared transport systems are demonstrated to lower operational overhead through the utilisation of aggregated resources (Teixeira *et al.*, 2023). Furthermore, outsourcing enables SMEs to concentrate on their core business activities while entrusting logistics partners with the management of transportation issues. This can promote increased customer satisfaction, as logistics providers are frequently endowed with advanced technologies and expertise in route optimisation, tracking, and warehousing, as Alghofeli (2023) elaborates on the improvement of supply chain performance through information technology (Alghofeli, 2023).

Although outsourcing transportation offers advantages, it also involves inherent risks. Control over logistics operations may decrease, potentially resulting in service interruptions that adversely impact customer relationships (Monnagaaratwe *et al.*, 2022). Furthermore, small and medium-sized enterprises may face difficulties concerning information exchange and quality control when partnering with third-party logistics providers (Namagembe & Mbago, 2023). SMEs must prioritise effective communication and establish well-defined performance metrics to mitigate these risks. The utilisation of outsourced providers may also introduce difficulties concerning the adaptability and promptness necessitated by fluctuating market dynamics. The swift changes in consumer behaviour observed during the pandemic highlight the importance of flexible supply chains that can respond effectively to disruptions (Burgos *et al.*, 2021). Failure to sustain agility within transportation logistics can impede a small-to-medium enterprise's competitive advantage.



2.3 Shared Transportation Models

Shared logistics and collaborative transportation represent an innovative paradigm within the logistics industry, wherein multiple stakeholders combine their resources to optimise operational efficiency and decrease expenses. is defined by the cooperation among multiple logistics providers, enabling the sharing of assets like warehouses, transportation vehicles, and information technology systems. Collaborative logistics (CL) is predicated on its ability to improve supply chain efficiency via operational streamlining, thereby enabling firms to realise economies of scale and maximise resource utilisation (Ghomi *et al.*, 2023).

For example, Ghomi *et al.* (2023) have developed a model illustrating how collaboration among carriers can result in substantial cost savings and improved service quality. Wang *et al.* (2020) further emphasise the significance of collaboration and resource sharing in tackling complex vehicle routing problems, demonstrating that the incorporation of such collaborative mechanisms can improve resource utilisation. The integration of communication and information technologies is essential in this context, as it enables the efficient coordination of resources between parties, thereby enhancing the overall effectiveness of the logistics network (Wang *et al.*, 2022). Horizontal Logistics Collaboration (HLC) represents a specific form of collaborative logistics, distinguished by alliances among companies operating at a comparable stage within the supply chain. Hammoud *et al.* (2024) elaborate on the efficacy of HLC in reducing overall transportation emissions, as it facilitates synchronised deliveries, resulting in optimised equipment utilisation and minimised carbon footprints.

The adoption of shared transport models offers significant benefits in cost efficiency and operational flexibility for small and medium-sized enterprises (SMEs). Oyeyemi *et al.* (2023) observed that resource optimisation via collaborative approaches enables small and medium-sized enterprises (SMEs) to reduce logistics expenditures, thereby improving their competitive position. This is further supported by Monnagaaratwe *et al.* (2022), who highlight that shared transport results in substantial cost reductions and increased operational efficiency for SMEs, thereby strengthening their capacity to compete in the marketplace. Cooperative transportation methods not only decrease immediate transport expenditures but also augment supply chain adaptability. Through the implementation of a shared logistics model, small and medium-sized enterprises (SMEs) can dynamically adapt their operational strategies to accommodate shifting market requirements while concurrently mitigating the inefficiencies often linked to underused resources (Wang *et al.*, 2022; Oyeyemi *et al.*, 2023). The evolving nature of customer demands requires a more adaptable logistical framework, wherein collaborative models are employed to meet customer requirements effectively and efficiently.

Furthermore, the significance of environmental sustainability in shared logistics should not be underestimated. The deliberate minimisation of vacant miles and the



improvement of delivery routes lead to decreased environmental effects and lower operational expenses, resulting in a dual advantage (Do *et al.*, 2019). As outlined in the study by Do *et al.* (2019), logistical collaboration has the potential to decrease delivery times and travel distances, thereby advancing sustainability within urban logistics.

2.4 Competitiveness in Grocery SMEs

Small and medium-sized grocery enterprises generally face challenges related to elevated operational expenses owing to their limited economies of scale relative to larger competitors. Efficient supply chain management (SCM) can alleviate these expenses, enabling small and medium-sized enterprises (SMEs) to sustain their competitive cost advantage. For example, the research conducted by Kgwadi *et al.* (2025) highlights the integration of third-party logistics (3PL) as a vital strategy for enhancing stock availability and decreasing operational costs. Similarly, Oyeyemi *et al.* (2023) highlight that supply chain collaboration can optimise resource utilisation by facilitating SMEs in sharing logistics and distribution networks, thus reducing operational costs and improving service reliability.

Maintaining service reliability is of paramount importance within the grocery sector, given elevated consumer expectations. Operational frameworks such as Lean Management and Total Quality Management (TQM), as proposed by Nyangoma *et al.* (2024), delineate strategies for minimising waste and improving service delivery, thereby resulting in increased customer satisfaction. A critical differentiator is also the capacity for improved responsiveness; the ability to rapidly adapt to evolving consumer needs is paramount for smaller entities operating within this competitive environment. According to the research conducted by Monnagaaratwe *et al.* (2022) collaborative supply chain management strategies improve product flow and foster a more responsive supply chain, thereby ensuring the efficient fulfilment of customer requirements.

Logistics significantly contributes to the competitive advantage of small and medium-sized enterprises (SMEs) within the grocery sector. The capacity to effectively oversee logistics operations not only diminishes expenses but also improves customer satisfaction. Ding *et al.* (2019) posit that small and medium-sized enterprises (SMEs) that utilise third-party warehousing and transportation services can realise substantial reductions in warehousing expenditures while retaining adaptability to fluctuations in order volume. For SMEs hoping to compete against bigger companies with stronger logistics infrastructures, this flexibility is essential.

Furthermore, the implementation of advanced technologies, as outlined by Awonuga *et al.* (2024), facilitates digital transformation in logistics operations. Leveraging technologies such as Artificial Intelligence (AI) and the Internet of Things (IoT) enables small and medium-sized enterprises (SMEs) to optimise logistics, inventory management, and responsiveness to evolving market dynamics. This digital



transformation advances operational efficiency, resulting in cost reductions, elevated service quality, and ultimately, a more robust competitive position.

However, establishing supply chain resilience is essential for small and medium-sized enterprises to mitigate disruptions and preserve their competitive advantage. Nugroho *et al.* (2025) emphasise that resilient firms are better equipped to adapt to market fluctuations, maintain operational efficiency, and consequently attain a competitive advantage. According to Babu *et al.* (2022), SMEs can leverage the benefits offered by specialised logistics services while concentrating on their main business operations by carefully choosing their logistics partners.

2.5 Theoretical Lens

The Resource-Based View (RBV) offers a suitable theoretical framework for analysing grocery SME owners' perceptions of shared outsourced transportation as a strategy to lower delivery costs and improve competitiveness. RBV asserts that organisations attain sustained competitive advantage through the effective acquisition, deployment, and utilisation of valuable, rare, inimitable, and non-substitutable (VRIN) resources. For small and medium-sized grocery enterprises, transportation capacity frequently constitutes a vital yet limited resource owing to constraints in financial resources, infrastructure, and negotiating leverage. Consequently, numerous small and medium-sized enterprises encounter difficulties in cultivating internal logistical competencies that satisfy stipulations regarding cost, reliability, and responsiveness.

Collaborative outsourced transportation provides grocery small and medium-sized enterprises (SMEs) access to logistical resources and capabilities that would be otherwise inaccessible to them individually. Through collaboration with logistics service providers and engagement in shared distribution networks, small and medium-sized enterprises can harness collective scale, specialised expertise, and sophisticated transportation infrastructure. From an RBV perspective, although the tangible transportation assets themselves may not be scarce, the capacity of SME owners to effectively integrate, coordinate, and oversee shared logistics relationships represents a strategic competency. This relational and managerial competence can serve as a source of competitive advantage by enhancing cost efficiency, service dependability, and market agility. Furthermore, the RBV emphasizes the significance of managerial perceptions and decision-making in identifying and leveraging strategic resources. An examination of SME owners' perceptions is consequently essential, given that their interpretations of value, risk, and control affect the utilisation of shared outsourced transportation and its potential to generate a competitive advantage. In this context, shared outsourced transportation serves as a facilitating resource that assists grocery SMEs in enhancing their competitive positioning within highly cost-sensitive retail markets.



2.6 Research Gap

While transportation cost management is increasingly recognised as critical for improving the competitiveness of small and medium-sized enterprises (SMEs) in the grocery sector, the current body of academic research is primarily characterised by quantitative, cost-centric, and firm-specific investigations. There is a significant lack of qualitative, perception-oriented research examining how small and medium-sized grocery business proprietors perceive and interpret the implementation of shared outsourced transportation within their routine operational environments. Existing research offers insufficient understanding of the lived experiences, decision-making processes, and perceived benefits or drawbacks related to shared transport arrangements, specifically from the perspective of small and medium-sized enterprise (SME) proprietors. Furthermore, numerous studies employ a broad or large-firm perspective, providing inadequate context-specific insights into the constraints, capabilities, and strategic factors distinctive to grocery SMEs. This deficiency of decision-maker-focused insight hampers the formulation of practical, contextually appropriate logistics strategies and policy measures. Employing qualitative research to address this deficiency facilitates a more comprehensive comprehension of the perceptions, adoption, and utilisation of shared outsourced transportation in fostering competitiveness within grocery SMEs.

3. Research Methodology

3.1 Research Philosophy and Approach

This study is based on an interpretivist research philosophy, which is particularly appropriate for examining the subjective meanings, perceptions, and experiences of grocery SME proprietors concerning shared outsourced transportation. Interpretivism posits that reality is socially constructed, and that knowledge is obtained through individuals' interpretations of their actual experiences, rather than solely through objective measurement. The interpretivist paradigm in this study allows for a detailed understanding of how SME owners evaluate the benefits of shared transportation arrangements, perceive delivery cost pressures, and make strategic decisions within their operational circumstances.

Consistent with this philosophical perspective, the study employs a qualitative, exploratory research methodology. A qualitative approach is suitable as it facilitates comprehensive examination of intricate logistics practices and strategic factors that cannot be sufficiently represented through quantitative data. The exploratory approach to this design is warranted by the paucity of extant qualitative research concerning shared outsourced transportation within the context of grocery small and medium-sized enterprises. This method enables the recognition of emerging themes,



contextual obstacles, and perceived advantages straight from the viewpoints of decision-makers. Employing an interpretivist paradigm and a qualitative exploratory design, this study offers comprehensive, contextually detailed insights into the comprehension and application of shared outsourced transportation as a strategy to improve competitiveness within grocery small and medium-sized enterprises (SMEs).

3.2 Research Design

This study employs a qualitative, case study research design, with the possibility of a multi-case approach to encompass varied perspectives among distinct grocery SMEs. A case-based or multi-case qualitative methodology is suitable as it facilitates a comprehensive analysis of real-world logistics practices and decision-making processes within their authentic business environments. Through the examination of individual cases, this study investigates the experiences, interpretations, and implementation of shared outsourced transportation among grocery SME owners. Furthermore, a multi-case design facilitates cross-case comparisons, enabling the identification of prevalent patterns and context-dependent variations.

The rationale for employing qualitative inquiry stems from the exploratory character of the research problem and the necessity to comprehend subjective perceptions rather than to establish causal relationships. Quantitative methodologies alone are inadequate for fully representing the intricacies, interpretations, and strategic factors inherent in the transportation decisions of small and medium-sized enterprise proprietors. A qualitative design enables participants to express their experiences, challenges, and perceived benefits of shared outsourced transportation in their own words, thereby producing detailed, contextualised insights. This approach improves the study's capacity to elucidate how and why shared outsourced transport is regarded as an effective strategy for lowering delivery costs and improving competitiveness among grocery SMEs.

3.3 Study Context

The study is conducted within the small and medium-sized enterprise (SME) sector of grocery retail in Mahikeng in the North West Province, which functions in a highly competitive and cost-conscious market environment. Grocery small and medium-sized enterprises are essential to local economies by offering accessible food products, encouraging employment opportunities, and contributing to community development. However, these enterprises encounter substantial logistical difficulties, especially in overseeing transportation and delivery expenses related to frequent replenishments and perishable commodities. The research is carried out within a defined geographical setting, where infrastructural limitations, market forces, and regulatory frameworks further impact logistics decision-making. Analysing grocery SMEs within this context facilitates a more comprehensive understanding of how shared outsourced transport is perceived and employed by owners as a strategic



measure to address cost pressures and competitiveness challenges inherent to their specific operating environment.

3.4 Sampling Strategy

The target population for this study includes owners and senior administrators of small and medium-sized grocery enterprises who are directly engaged in logistics and transportation decision-making within their organisations. These participants were optimally positioned to offer informed insights into the adoption and perceived value of shared outsourced transportation. A purposive sampling method was utilised to deliberately select participants with pertinent experience in transportation outsourcing or shared logistics arrangements. This method guaranteed that the data gathered is comprehensive and corresponds with the aims of the study. Snowball sampling was also be employed to identify additional appropriate participants through referrals, especially in instances where access to SME proprietors is restricted. Inclusion criteria stipulate that participant had to be owners or administrators of grocery small and medium-sized enterprises with a minimum of one year of operational experience and active involvement in delivery or transportation decision-making. The exclusion criteria encompass large retail chains, franchise-operated grocery stores, and individuals lacking direct responsibility for logistics-related decisions, thereby ensuring the study's focus on independent grocery SMEs.

3.5 Data Collection

Semi-structured interviews were conducted with twelve grocery SME owners and managers. Data saturation was achieved at the twelfth interview, as no new themes or insights emerged from subsequent data analysis. This data collection method was suitable as it enabled participants to openly articulate their experiences, perceptions, and decision-making processes concerning shared outsourced transport, while assuring comprehensive coverage of all essential research topics. A structured interview protocol was formulated in accordance with the study's research aims and guided by pertinent scholarly sources. The interview protocol consisted of open-ended enquiries concerning challenges related to delivery costs, rationales for outsourcing transportation functions, experiences with collaborative logistics initiatives, and assessed effects on competitive positioning. Before the primary data collection, the interview guide was examined and refined through expert consultation and a pilot interview to ensure clarity and pertinence. Data collection was carried out iteratively and persisted until data saturation was reached. Data saturation was achieved when subsequent interviews failed to yield novel themes or significant insights, thus validating the credibility and comprehensiveness of the qualitative data.

3.6 Data Analysis



Data analysis was performed employing a thematic analysis methodology, which was suitable for detecting, examining, and interpreting patterns of meaning within the qualitative data. Initially, the interview transcripts were subjected to repetitive readings to facilitate familiarisation with the data. An initial open coding procedure was subsequently implemented, during which significant segments of text were methodically annotated to identify key ideas and concepts arising from participants' narratives. These preliminary codes were subsequently refined and organised through axial coding to discern relationships, identify patterns, and establish broader categories within the dataset. Selective coding was subsequently utilised to synthesise and consolidate the central themes that aligned with the research objectives of the study. Where applicable, qualitative data analysis software was employed to facilitate data administration, ensure coding consistency, and improve the transparency of the analytical process. Software utilisation streamlined transcript organisation, facilitated efficient data retrieval, and augmented the thoroughness of theme development. This structured analytical procedure made sure that the grocery SME owners' views on shared outsourced transport were interpreted in a way that was both credible and clear.

3.7 Trustworthiness of the Study

The reliability of the study was established by applying the four criteria outlined for qualitative research: credibility, dependability, transferability, and confirmability. Credibility was strengthened through the utilisation of semi-structured interviews, which facilitated comprehensive engagement with participants, extended interaction during data collection, and iterative inquiry to elucidate meanings. Where appropriate, member checking was utilised to confirm the veracity of interpretations and to ensure that the findings faithfully represented participants' perspectives.

Reliability was ensured through the establishment of a transparent and methodical audit trace of the research process, encompassing documentation of the research design, data collection methods, and analytical choices. Transferability was facilitated by providing detailed, comprehensive descriptions of the study context, participants, and findings, allowing readers to evaluate the relevance of the results to comparable grocery SME environments. Confirmability was maintained through the practice of reflexivity, the documentation of analytical memos, and the anchoring of interpretations in empirical data, thereby reducing researcher bias and promoting objectivity.

3.8 Ethical Considerations

Ethical considerations were thoroughly examined throughout the study to safeguard the rights and well-being of all participants. Informed consent was secured prior to data collection, with participants receiving a comprehensive information document detailing the study's objectives, research procedures, and their rights as participants.



Consent was provided voluntarily and in writing prior to the commencement of interviews.

Confidentiality and anonymity were rigorously preserved by eliminating all identifiable information from interview transcripts and employing pseudonyms or coded identifiers in the presentation of the findings. No personal or organisational information that could potentially disclose participants' identities was revealed. Participation in the study was completely voluntary, and participants were duly informed of their right to withdraw at any point without facing any adverse consequences. These ethical protocols guaranteed adherence to established research ethics standards and fostered trust and transparency throughout the research process.

4. Findings

Table 4.1 provides a summary of the twelve participants involved in this study. The table provides an overview of participants' roles, business contexts, and levels of responsibility in logistics and transportation decision-making. All information is provided in anonymised format to maintain confidentiality and to offer contextual clarity for the interpretation of the subsequent findings.

Table 4.1 Participant Profiles

Participant	Role	Grocery SME Context	Logistics Responsibility
P1	Owner-Manager	Independent grocery SME with over five years of operation	Oversees delivery scheduling and coordination with external transport providers
P2	Senior Manager	Medium-sized grocery SME	Manages procurement-related distribution and outsourced transportation arrangements
P3	Owner	Neighbourhood grocery store operating for more than three years	Directly manages delivery costs and transport service negotiations
P4	Co-Owner	Grocery SME with multiple suppliers and frequent delivery requirements	Responsible for logistics planning and cost evaluation
P5	Operations Manager	Grocery SME utilising outsourced delivery services	Coordinates day-to-day transportation and supplier deliveries



P6	Owner	High-volume independent grocery SME	Manages logistics provider relationships and delivery efficiency
P7	Senior Manager	Growing grocery SME	Oversees distribution efficiency and transportation cost control
P8	Owner-Manager	Long-established grocery SME	Responsible for delivery frequency and transportation outsourcing decisions
P9	Owner	Grocery SME operating in a competitive retail environment	Explores collaborative and shared logistics arrangements
P10	Senior Manager	Grocery SME with multiple supplier relationships	Monitors transportation performance and delivery reliability
P11	Owner	Small grocery SME with limited internal logistics capacity	Relies primarily on outsourced transportation solutions
P12	Owner	Independent grocery SME with extensive delivery experience	Negotiates and manages shared transportation arrangements

Source: Authors construction

4.1 Emergent Themes

Analysis of the interview data identified four interrelated themes that illustrate grocery SME proprietors' perceptions of shared outsourced transportation. These themes encompass participants' perspectives on the perceived cost-saving advantages, operational flexibility, risk-sharing, the challenges and concerns related to shared transport arrangements, and the impact of shared transport on competitiveness and market positioning. Together, the themes offer a thorough comprehension of how shared outsourced transportation is perceived and assessed by grocery SME owners within their operational environments.

4.1.1 Perceived cost-saving benefits of shared outsourced transportation

- ❖ *"Sharing transport has reduced what we spend on deliveries because the cost is split."* (P1)
- ❖ *"We no longer feel the full impact of fuel increases since transport costs are shared."* (P2)
- ❖ *"Using shared delivery is cheaper than hiring transport on our own each time."* (P3)



- ❖ *“Our monthly delivery expenses became more predictable with shared transport.” (P4)*
- ❖ *“It helped us save on vehicle-related costs like maintenance and emergency deliveries.” (P6)*
- ❖ *“Shared transport made deliveries more affordable for a small business like ours.” (P7)*
- ❖ *“The biggest benefit is paying less per delivery compared to operating alone.” (P9)*

Participants consistently regarded shared outsourced transportation as an effective strategy for minimising delivery-associated expenses. A few participants said that consolidating deliveries with other grocery SMEs facilitated the sharing of transportation costs, thereby reducing individual delivery fees. Participants emphasised the cost reductions related to fuel expenses, vehicle maintenance, and decreased dependence on irregular delivery arrangements. Several participants observed that shared conveyance provided improved cost predictability, facilitating better budgeting and financial planning. These perceived cost efficiencies were regarded as especially advantageous in an environment characterised by slim profit margins and frequent supplier deliveries.

4.1.2 Operational flexibility and risk-sharing

- ❖ *“Shared transport allows us to adjust delivery volumes when demand changes.” (P5)*
- ❖ *“If there is a delay, the risk is not carried by one business only.” (P8)*
- ❖ *“It gives us flexibility because transport is arranged collectively.” (P10)*
- ❖ *“We don’t panic as much when something goes wrong because it’s a shared system.” (P12)*
- ❖ *“Shared delivery helps when demand suddenly increases.” (P3)*
- ❖ *“We feel less exposed to delivery problems when transport is shared.” (P6)*
- ❖ *“It reduces the pressure of managing transport risks alone.” (P11)*

Operational flexibility has become a recognised primary advantage of outsourced shared transport. Participants indicated that collaborative arrangements facilitated more flexible adjustments to delivery volumes and schedules in response to varying demand. Emphasis was also placed on risk-sharing, specifically concerning vehicle malfunctions, delivery setbacks, and fluctuations in fuel prices. Through engagement with shared transport networks, participants reported diminished vulnerability to operational interruptions and logistical ambiguities that would typically be experienced independently.

4.1.2 Challenges and concerns associated with shared transportation

- ❖ *“Sometimes the delivery times do not match what our store needs.” (P4)*
- ❖ *“We depend on others, which can cause delays.” (P2)*
- ❖ *“There is less control over delivery schedules with shared transport.” (P7)*
- ❖ *“Coordination becomes difficult when many businesses are involved.” (P9)*



- ❖ *“If something goes wrong, it’s not always clear who is responsible.” (P5)*
- ❖ *“Service quality can drop if transport providers are not well organised.” (P10)*
- ❖ *“Trust is important, and sometimes it is hard to trust shared arrangements.” (P1)*

Although acknowledging the purported advantages, participants articulated several concerns pertaining to shared outsourced transportation. These factors encompassed diminished control over delivery schedules, reliance on external coordination efforts, and the potential for conflicts stemming from schedule discrepancies among participating small and medium-sized enterprises. Several participants expressed concerns regarding service reliability, accountability, and the potential for delays to impact customer satisfaction. Trust between participating businesses and logistics providers was recognised as a vital yet occasionally delicate component of collaborative arrangements.

4.1.3 Perceived influence on competitiveness and market positioning

- ❖ *“Lower delivery costs help us keep prices competitive.” (P6)*
- ❖ *“Shared transport allows us to compete with larger grocery stores.” (P8)*
- ❖ *“We can focus more on sales because delivery costs are under control.” (P3)*
- ❖ *“It improves our efficiency without needing big investments.” (P11)*
- ❖ *“Shared delivery supports better stock availability for customers.” (P2)*
- ❖ *“It helps us survive in a competitive market.” (P7)*
- ❖ *“Shared transport improves our position, but reliability is very important.” (P12)*

Participants generally perceived shared outsourced conveyance as having a positive influence on their competitiveness. Cost reductions were regarded as facilitating more competitive pricing, while improved delivery reliability contributed to improved service levels. Several participants noted that shared transport improved their capacity to compete with larger retailers by increasing operational efficiency without requiring substantial capital investment. Nonetheless, participants observed that the competitive advantages depended on efficient coordination and uniform service delivery.

4.2 Summary of Key Insights

The results of this study suggest that grocery SME proprietors typically regard shared outsourced transportation as an effective approach for addressing delivery cost pressures. Participants indicated that the sharing of transportation resources facilitated cost savings through decreased fuel expenditures, reduced per-delivery charges, and improved cost predictability. Operational flexibility and risk-sharing were also identified as significant advantages, as collaborative arrangements enabled small and medium-sized enterprises (SMEs) to adjust delivery timelines in response to fluctuating demand while mitigating individual vulnerability to logistical interruptions. However, the findings also identified significant challenges, such as diminished control over delivery schedules, coordination obstacles, and concerns related to service



dependability and accountability. Trust and efficient communication between participating SMEs and logistics service providers were identified as essential factors impacting the success of shared transport arrangements. Overall, participants regarded shared outsourced transportation as augmenting their competitiveness through the facilitation of cost-efficient operations and improved service quality, although the magnitude of these advantages was contingent upon sustained coordination and dependable transportation performance.

5. Discussion

5.1 Interpretation of Findings

The interpretation of the findings demonstrates a significant correlation between the emergent themes and the study's research objective, which aimed to examine grocery SME owners' perceptions of shared outsourced transportation as a strategy for lowering delivery costs and improving competitiveness. The theme concerning perceived cost-saving advantages directly aligns with the primary objective by illustrating that participants consistently regarded shared outsourced transportation as an efficient method for controlling delivery-related costs. Participants' perceptions of decreased petroleum expenses, collective delivery fees, and improved cost predictability demonstrate how shared transport was regarded as a pragmatic solution to the ongoing cost challenges encountered by grocery SMEs.

The theme of operational flexibility and risk-sharing further advances the research objective by emphasising the perceived value-added benefits of collaborative outsourced transportation. Participants correlated collaborative frameworks with improved flexibility in scheduling deliveries and diminished personal vulnerability to logistical challenges, including vehicle malfunctions, fuel cost volatility, and delivery postponements. These perceptions indicate that shared transport was regarded not merely as a means of cost reduction but also as a strategic method that improved the resilience and responsiveness of operations.

The theme concerning challenges and concerns offers significant contextual insight into the research objective by highlighting factors that limited the perceived effectiveness of shared transport. Concerns pertaining to coordination, diminished oversight, and the consistency of service reliability demonstrate that the advantages associated with distributed outsourced transportation were regarded as contingent rather than assured. These issues highlight the critical significance of governance, trust, and effective communication in influencing the perceptions and experiences of SME proprietors.

The theme centred on competitiveness and market positioning connects perceived costs and operational advantages to overarching strategic results. Participants reported that utilising shared outsourced transportation correlated with increased pricing flexibility, elevated service standards, and a greater capacity to compete



effectively with larger retailers. The collective findings offer an in-depth knowledge of how grocery small and medium-sized enterprise (SME) proprietors view shared outsourced transportation as a strategy that can both facilitate and be contingent upon specific contexts to improve cost efficiency and competitiveness.

5.2 Comparison with Existing Literature

The results of this investigation are largely consistent with extant research, which identifies transportation expenses as a significant impediment to the competitiveness of small and medium-sized enterprises, especially within the grocery retail industry. Previous research has consistently demonstrated that shared and outsourced transport models can facilitate cost reductions for SMEs by leveraging economies of scale, decreasing fuel costs, and minimising capital investment in logistics infrastructure. The participants' perceptions of cost savings and improved cost predictability corroborate these established findings, reinforcing the perspective that collaborative logistics arrangements can alleviate the structural disadvantages encountered by smaller firms.

The study further corroborates previous research highlighting the significance of logistics outsourcing in improving operational flexibility and facilitating risk-sharing. Previous research indicates that shared transport arrangements enable small and medium-sized enterprises to respond more efficiently to fluctuations in demand and to mitigate risks associated with operational disruptions. Participants' reports of improved flexibility and diminished personal risk align with these findings, demonstrating consistency between empirical observations and theoretical projections

Nevertheless, the findings also contrast with certain optimistic representations in the literature that depict shared transport as an invariably advantageous solution. Although previous research frequently emphasises efficiency improvements, this study emphasises enduring apprehensions concerning coordination complexities, diminished oversight of delivery timelines, and service dependability. These challenges indicate that the results of shared transport are extremely context-specific and significantly affected by relational and governance factors. This study, by emphasising the lived experiences of small and medium-sized enterprise (SME) owners, expands upon the current literature by elucidating the complex circumstances under which shared outsourced transportation is viewed favourably or unfavourably, thus providing a more comprehensive and context-dependent understanding of collaborative logistics within grocery SMEs.

5.3 Theoretical Implications

This study contributes to the existing body of knowledge concerning small and medium-sized enterprise (SME) logistics and transportation by expanding the comprehension of shared outsourced transportation through a qualitative, perception-driven approach. Although extant theoretical models frequently frame transportation



outsourcing through the lenses of cost effectiveness and transaction optimisation, the results of this research underscore the significance of managerial perceptions, relational dynamics, and contextual factors in determining the strategic value of collaborative logistics arrangements for grocery SMEs. Through an emphasis on the lived experiences of small and medium enterprise (SME) proprietors, this study illustrates that transport capabilities should be understood not only as tangible resources but also as socially constructed and managerially enacted capabilities.

Based on the Resource-Based View, the results indicate that shared outsourced transport serves as an enabling resource. This enables small and medium-sized enterprises (SMEs) to access logistical capabilities that exceed their internal capacity. However, the study further demonstrates that competitive advantage is not solely derived from access to shared transport, but from the capacity of SME owners to coordinate, administer, and seamlessly integrate these shared resources. This focus on relational and managerial capabilities improves a more sophisticated comprehension of how logistics resources are converted into competitive advantages within small and medium-sized enterprise environments.

Furthermore, the study advances SME logistics theory by elucidating the contingent nature of shared transportation advantages. Theoretical models frequently posit efficiency improvements stemming from collaboration; however, empirical results suggest that governance structures, trust levels, and coordination efforts substantially affect observed outcomes. Consequently, this research improves transportation theory by integrating behavioural and contextual factors, thus providing a more comprehensive framework for analysing collaborative logistics strategies among grocery SMEs.

5.4 Practical Implications

The findings of this study offer significant practical implications for proprietors of grocery SMEs, logistics service providers, and policymakers. For small and medium-sized grocery business proprietors, shared outsourced transportation is regarded as an effective approach to reduce delivery cost pressures and improve operational efficiency. However, the findings suggest that the effectiveness of such arrangements relies on efficient coordination, mutual trust among participating SMEs, and transparent communication with logistics partners. SME proprietors are advised to actively participate in the governance of shared transport systems to guarantee their alignment with operational requirements and service standards.

For logistics service providers, the study emphasises the importance of developing customised shared transportation solutions that acknowledge the limitations and variability encountered by grocery SMEs. Providers should prioritise providing adaptable scheduling options, transparent pricing models, and explicitly defined



accountability measures. Improving reliability and communication can encourage greater trust and promote enduring collaboration with SME clients.

Based on the study's findings, policymakers and agencies providing support to small and medium-sized enterprises (SMEs) should consider facilitating collaborative logistics initiatives as part of their policy and program agendas. Support programs can advance shared transport by utilising coordination platforms, providing financial incentives, and implementing training initiatives designed to improve the logistics management capabilities of SMEs. Such interventions can improve the sustainability and competitiveness of grocery SMEs in challenging market conditions.

6. Conclusion

This study examined the perceptions of small and medium-sized grocery business proprietors regarding shared outsourced transportation as a strategy to lower delivery expenses and improve competitiveness. The study's results indicated that participants generally viewed shared transportation as an effective method for controlling delivery-related expenditures through cost-sharing, improved cost predictability, and diminished exposure to fuel and maintenance expenses. Operational flexibility and risk-sharing were further recognised as significant perceived advantages, allowing SMEs to adapt to demand variability and reduce uncertainties associated with logistics. Conversely, the research also revealed difficulties pertaining to coordination, diminished oversight of delivery timelines, and apprehensions concerning service dependability. Despite these limitations, participants predominantly regarded shared outsourced transport as a positive factor enhancing competitiveness through the facilitation of cost-effective operations and elevated service quality. This study improves the existing body of information by providing qualitative, perception-based insights into shared transportation practices within SME logistics and transportation literature, emphasising the significance of managerial interpretation and relational dynamics. The results collectively emphasise the significance of collaborative outsourced transportation as a strategically pertinent, context-specific strategy for grocery small and medium-sized enterprises.

This study is subject to multiple limitations, the qualitative design and small sample size methodologically constrain the generalisability of the findings outside the analysed setting. The scope of this study was limited to grocery small and medium-sized enterprises (SMEs) operating within a specific context; thus, the generalisability of the results to other sectors or geographic regions may be restricted. Furthermore, dependence on self-reported perceptions may induce subjective bias.

Based on participant insights, grocery SMEs are advised to implement shared conveyance arrangements facilitated by well-defined coordination mechanisms and trust-based partnerships. Logistics service providers should improve transparency and dependability within shared models. Future research may utilise mixed methods



approaches to quantify cost implications or conduct comparative analyses across sectors and regions to improve understanding of shared outsourced transportation strategies.



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Strategic operational management and its effect on the performance of spaza shops in the Eastern Cape, South Africa

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Abstract

The purpose of this study is to examine the effect of strategic operational management on the performance of locally owned spaza shops in the Eastern Cape Province, South Africa. Spaza shops play a vital role in the informal economy, acting as essential sources of goods and services for local communities. As these businesses are often family-run and operate with limited resources, understanding the factors that influence their performance is critical for enhancing their sustainability and growth.

A quantitative research design was adopted for this study, employing convenience sampling to gather data from 203 spaza shop operators. Structured questionnaires were used to collect relevant information, enabling a detailed analysis of operational practices among these retailers. The data were then analysed using Structural Equation Modelling (SEM), a robust statistical technique that reveals the relationships between variables.

The study's findings highlight a statistically significant positive relationship between effective strategic operational management and business performance. Specifically, the results indicate that operational practices such as efficient supply chain management, effective inventory control, robust customer engagement strategies, and the adoption of innovative technologies significantly enhance profitability, operational efficiency, and overall competitiveness among locally owned spaza shops.

Given the critical role that spaza shops play in supporting local livelihoods and fostering informal economic activity, enhancing their operational capabilities has broader implications. Not only does it contribute to individual business performance, but it also bolsters community resilience and supports sustainable local economic development.

To this end, the study proposes a context-specific strategic operational management framework tailored to the unique challenges faced by informal retail in the Eastern Cape. This framework aims to provide practical guidance for shop owners, policymakers, and development stakeholders, facilitating improved operational practices and ultimately contributing to the long-term sustainability of spaza shops within the region.



Keywords: customer engagement initiatives, innovative operational strategies, socio-economic fabric, strategic business operation management, technology adoption.

Introduction

Background

In the dynamic retail landscape, locally owned spaza shops play a vital role in meeting communities' daily needs, particularly in provinces like the Eastern Cape (Lamb et al., 2019). Nason et al. (2024) contend that these small, independently operated businesses contribute significantly to the local economy, providing employment opportunities and acting as crucial sources of goods and services. According to Charman (2017), the nation's informal economy sustains the lives of 14.9 million adults who are legally classified as "not economically active" and 4.4 million unemployed individuals, while also giving at least 2.4 million people (13% of the labour force) jobs. To thrive in a competitive market, these spaza shops require effective strategic operational management that aligns with the unique challenges and opportunities presented by their specific environment (Mbhenyane & Tambe, 2024).

Strategic operational management involves formulating and implementing plans and initiatives to optimise a business's internal processes, ensuring efficiency and effectiveness in achieving organisational goals (Choi et al., 2022). As we move into the industry 4.0 era, smart, data-driven operations are becoming the norm in production and operations management (OM). In the context of spaza shops in the Eastern Cape, factors such as economic conditions, customer preferences, supply chain challenges, and local regulations significantly influence the operational landscape (Zhang et al., 2024).

It is imperative that local spaza shop owners and the communities they serve comprehend how strategic operational management affects their business (Alsharari, 2024). Increased profitability, higher customer satisfaction ratings, and greater resilience to outside obstacles are all possible outcomes of efficient operations (Choi et al., 2022).

This study explores the intricate relationship between strategic operational management and the performance of locally owned spaza shops in the Eastern Cape, aiming to offer insights that guide owners, policymakers, and stakeholders in building a resilient, thriving small-business ecosystem. As we delve deeper into these dynamics, it becomes evident that a well-crafted operational strategy is pivotal for spaza shops to navigate challenges, capitalise on opportunities, and contribute to the economic and social fabric of the Eastern Cape.

Problem Statement

Locally owned spaza shops play a critical role in sustaining livelihoods, improving food access, and supporting local economies in South Africa, particularly in the Eastern Cape Province (Kativhu, 2022). Despite their socio-economic importance, many of these enterprises continue to perform poorly, exhibit low profitability, and face high failure rates. This underperformance is often attributed to weak operational structures, inadequate inventory control, limited adoption of technology, inefficient supply chain practices, and the absence of formal strategic operational management approaches (Modiba, 2023).



While existing literature recognises the contribution of spaza shops to the informal economy, there remains a limited empirical understanding of how strategic operational management practices directly influence the performance of locally owned spaza shops, especially within the unique socio-economic context of the Eastern Cape. Many spaza shop operators rely on informal, experience-based decision-making rather than structured operational strategies, which constrains their ability to compete with larger formal retailers and foreign-owned enterprises that employ more efficient business operations.

Furthermore, policy interventions and support programmes aimed at strengthening informal businesses often lack evidence-based insights into the specific operational factors that drive performance improvements among locally owned spaza shops. This gap restricts the effectiveness of interventions designed to promote sustainability, competitiveness, and long-term growth in the informal retail sector.

Therefore, the problem addressed in this study is the insufficient empirical evidence on the relationship between strategic operational management and the performance of locally owned spaza shops in the Eastern Cape Province. Addressing this problem is essential to inform spaza shop owners, policymakers, and development stakeholders on how strategic operational practices can be leveraged to enhance business performance, resilience, and contribution to local economic development.

1.3 Research Objectives

- Determine the relationship between strategic operational management and the performance of locally owned spaza shops.
- Evaluate the extent to which strategic operational management practices influence the performance of locally owned spaza shops.
- Provide managerial recommendations aimed at improving the performance and sustainability of locally owned spaza shops through effective strategic operational management.

1.4 Hypotheses

Guided by the Resource-Based View (RBV) theory and the Strategic Business Operations Management (SBOM) framework, the following hypothesis was formulated and tested:

- **H₀:** Strategic operational management does not have a statistically significant effect on the performance of locally owned spaza shops in the Eastern Cape Province.
- **H₁:** Strategic operational management has a statistically significant positive effect on the performance of locally owned spaza shops in the Eastern Cape Province.

Literature Review

The following sections present an analysis of the literature reviewed on the definition of locally owned spaza shops and strategic operations management. The review was conducted to determine strategic operational management and its impact on the performance of Eastern Cape's locally owned spaza shops. This is followed by a summary of the resource-based



perspective theory, which served as the theoretical basis for this investigation and explains spaza shops.

2.1 Definition of Locally Owned Spaza Shops

A locally owned spaza shop, often referred to simply as a "spaza shop" or "spaza," is a small, independently owned convenience store or informal retail business typically found in townships, rural areas, and informal settlements (Kativhu, 2022). The term "spaza" is derived from South African slang and means "hidden" or "concealed." These shops play a crucial role in serving local communities, especially in areas where access to formal retail establishments may be limited (Van Eyk, 2022). During the Apartheid era, "spaza shops," also known as hidden shops, gained popularity in South Africa and played a crucial role in providing essential goods to Black people living in rural areas and informal settlements (Kativhu, 2022).

It's important to note that the term "spaza shop" is commonly used in South Africa, but similar small, independently owned convenience stores exist under various names in other parts of the world (Modiba, 2023). The informal and community-focused nature of spaza shops makes them significant contributors to local economies and essential service providers in underserved areas (Gumede & Moyo, 2023).

2.2 Strategic Operations Management

Strategic business operations management (SBOM) refers to the systematic planning, implementation, and control of business processes to achieve long-term organisational goals and objectives (Zhang et al., 2024). It involves aligning operational activities with the business's overall strategic direction. SBOM integrates various elements, such as resources, processes, technologies, and people, to optimise efficiency, enhance performance, and create a competitive advantage for the organisation (Dolgui & Ivanov, 2022).

SBOM involves the strategic planning and execution of operational processes to achieve long-term business objectives. It requires a comprehensive understanding of the organisation's strategy, effective resource management, continuous improvement, and a focus on delivering value to customers and stakeholders (Zhou et al., 2022).

New business models are emerging as the internet economy rapidly grows (Awawdeh et al., 2022). Innovations in internet technology have a significant impact on both economic growth and entrepreneurship. The Internet has a significant influence on entrepreneurship in China, the greatest developing nation. This will benefit economic growth and the fight against poverty in other emerging nations (Tan & Li, 2022).

Wegerif (2020) found that local spaza shops operate temporarily to survive. Because locally owned spaza shops contribute to reduced unemployment (Beresford, 2020), they can eliminate labour costs while employing sufficient staff to operate the business over longer trading hours (Connor & Charway, 2020). Owners of small businesses typically take on the management job themselves or exercise intense control and supervision over how the company is run.



2.3 Resource-Based View Theory

The resource-based view (RBV) emphasises the significant influence of a company's resources and skills on its success (Taher, 2012). Originating in the 1980s from Wernerfelt, this theory underscores the crucial role of an organisation's resources and skills. To achieve sustainable competitiveness, businesses must possess resources and capabilities that competitors cannot easily replicate. These resources encompass various elements, including financial assets, manufacturing equipment, brand identity, technological expertise, marketing proficiency, and managerial acumen (McWilliams & Siegel, 2011, p. 28).

Ezennia and Mutambara (2022) contend that RBV is based on the evidence that firms' competitive advantages and subsequent performance originate in the resources and capabilities controlled by the organisations. Capabilities pertain to unique proficiencies in the effective administration, enhancement, and expansion of business-specific resources. The greater the recognition of distinctive resources and competencies within a business, the higher its comparative value relative to competitors. Consequently, enterprises possessing competitive resources may seamlessly penetrate new markets (Barratt & Oke, 2007).

Barratt and Oke (2007) contend that leveraging these resources and capabilities provides businesses with a competitive edge in market entry and profit generation. The advantage of this theory is that it can outperform competitors in a defined market. This theory assumes that resources must also be non-uniform and immobile (Taher, 2012). They must be heterogeneous. The first assumption promotes the uniqueness of skills and capabilities among organisations. There are some criticisms of RBV, but it is not easy to establish the proper level of criticism. This is because of the magnitude of explanations given to resources.

The RBV theory provides a framework for understanding how the unique resources and capabilities of locally owned spaza shops in the Eastern Cape can inform their strategic and operational decisions, ultimately influencing their market performance. Integrating RBV principles with strategic operational management practices can help these businesses gain a competitive edge in the challenging retail landscape.

2.4 Literature on strategic operational management and its impact on the performance of spaza shops

This section highlights the strategic operational management role in enhancing business performance, including that of small enterprises such as spaza shops. Key focus areas, such as supply chain efficiency, customer relationship management, inventory control, and technology adoption, are essential to the success of these informal retail outlets. Spaza shops in South Africa face frequent challenges, including limited access to resources, competition from larger retailers, and inefficiencies in their supply chains (Tan & Li, 2022). Strategic operational management offers solutions to these challenges by optimising business processes, which ultimately leads to improved profitability, customer satisfaction, and long-term sustainability (Vaka, 2024).

One of the core themes in the literature is the importance of supply chain management. For small businesses like spaza shops, a streamlined supply chain ensures a steady flow of



goods, minimising stock shortages that could result in customer loss (Esrar et al., 2023). Additionally, inventory management is critical in such setups, as efficient control of stock helps reduce waste, prevent stockouts, and optimise sales (Vaka, 2024). Studies show that effective inventory management plays a significant role in driving profitability for informal retail businesses.

The adoption of technology is another area where strategic operational management can have a substantial impact (Ghobakhloo et al., 2024). Digital tools such as mobile payment systems and inventory management software enhance operational efficiency, giving small retailers, such as spaza shops, a competitive edge (Awawdeh et al., 2022). Technology adoption has been linked to improved performance, better customer service, and greater competitiveness with larger retail outlets.

The impact of strategic operational management on spaza shops is profound. Businesses that implement efficient operational strategies often experience higher profitability and growth, as optimised processes reduce costs and increase sales (Zhang et al., 2024). Furthermore, such strategies promote sustainability by aligning business operations with local community needs and encouraging eco-friendly practices. In a competitive retail environment, spaza shops that manage their operations strategically are better equipped to resist pressures from larger, formal retailers while capitalising on their proximity to customers and personalised services (Dolgui & Ivanov, 2022).

Research Design and Methodology

3.1 Research Paradigm and Design

This study adopted a positivist research paradigm, which is appropriate for examining relationships between variables through objective measurement and statistical analysis. The positivist paradigm allows the researcher to test existing theories, such as the Resource-Based View (RBV) and Strategic Business Operations Management (SBOM), by quantifying relationships and drawing generalisable conclusions.

A descriptive research design was employed in this study. The design was suitable because it enabled the researcher to systematically describe and analyse the relationship between strategic operational management and the performance of locally owned spaza shops in the Eastern Cape Province without manipulating the research environment.

3.2 Research Approach

A quantitative research approach was adopted in this study. This approach was appropriate as it facilitated the collection of numerical data that could be statistically analysed to determine the nature, strength, and direction of the relationship between strategic operational management and spaza shop performance. The quantitative approach further supported the use of inferential statistics and Structural Equation Modelling (SEM) to test the formulated hypotheses objectively.

3.3 Research Method

The study utilised a survey research method to collect data from locally owned spaza shop operators. The survey method was selected because it allows for the collection of data from a relatively large number of respondents within a limited time frame and enables the researcher



to quantify perceptions and practices related to strategic operational management and business performance.

3.6 Population and Sample

The study population comprised locally owned spaza shops operating in the Eastern Cape Province of South Africa. A convenience sampling technique was employed to select respondents due to the informal nature of the businesses and the ease of participant access.

The sample size for the study was determined using the Raosoft (2004) sample size calculator, which recommended a sample size of 384 informal businesses based on a 5% margin of error, a 95% confidence level, a population size of 141,739 informal businesses in the Eastern Cape, and a response distribution of 50%. However, data were successfully collected from 203 locally owned spaza shops across the six district municipalities of the Eastern Cape, namely Alfred Nzo, OR Tambo, Chris Hani, Sarah Baartman, Joe Gqabi, and Amathole.

It is important to clarify that the population figure of 141,739 refers to the estimated number of informal enterprises operating in the Eastern Cape Province, rather than to registered spaza shops alone. Due to the informal and largely unregistered nature of locally owned spaza shops, obtaining an accurate sampling frame was not feasible. Consequently, a convenience sampling technique was adopted. While this approach limits the generalisability of the findings, it is appropriate within the context of informal-sector research, where access to a complete database of businesses is constrained. The study, therefore, provides empirically grounded insights within the practical constraints of limited access.

3.4 Research Instrument

Data were collected using a self-administered structured questionnaire. The questionnaire consisted of previously validated measurement scales aligned with the constructs of strategic operational management and business performance. The instrument was designed to ensure clarity, relevance, and alignment with the study's objectives.

To ensure measurement reliability and validity, internal consistency was assessed using Cronbach's alpha and composite reliability (CR). All constructs exceeded the recommended threshold of 0.70, indicating satisfactory reliability. Convergent validity was assessed using Average Variance Extracted (AVE), with values exceeding the minimum threshold of 0.50. Discriminant validity was confirmed by ensuring that the square root of the AVE for each construct exceeded the inter-construct correlations. These results demonstrate that the measurement model is both reliable and valid for structural equation modelling analysis.

3.5 Data Collection

Data collection was conducted using self-administered, self-completed, and drop-off questionnaires distributed to locally owned spaza shop operators across the Eastern Cape Province. The use of self-administered questionnaires enabled efficient data collection across geographically dispersed areas and minimised interviewer bias. This approach was also time- and cost-efficient, enabling the researcher to collect a substantial volume of quantitative data within a relatively short period.

3.6 Ethical Considerations



Ethical approval for the study was obtained from the University of Fort Hare Research Ethics Committee and the Inter-Faculty Research Ethics Committee (Ethical clearance number: ONI031SFIH01) prior to data collection. The researcher ensured that ethical principles, including informed consent, voluntary participation, anonymity, confidentiality, and the right to withdraw, were upheld throughout the research process. In addition, all findings were reported honestly and objectively, and the researcher complied with the Protection of Personal Information Act (POPIA) during data collection and data handling.

Results and Findings

The empirical results focus on reporting on strategic operational management and its impact on the performance of Eastern Cape's locally owned spaza shops. The results are presented in two stages. First, the measurement model was assessed to evaluate the reliability and validity of the constructs. Second, the structural model was analysed to examine the hypothesised relationship between strategic operational management and business performance.

4.1 Biographical Data of Respondents

Before conducting a detailed analysis of the data, the demographic profile of the respondents was explored through basic distributions. A descriptive approach was employed to present the study's biographical variables, which were visually summarised using charts and graphs for clarity and better understanding. Figure 4.1 indicates that more males (81.8%) participated in the study than females (17.2%). Figure 4.2 shows that the majority of respondents in the 35-44 age range participated in the study. Figure 4.3 depicts that the majority of respondents below matric participated in the study, followed by matric, certificate, diploma/degree, and post-graduate. Regarding the distribution of municipalities, Figure 4.4 shows that more participants from Alfred Nzo District Municipality participated in the study, followed by Amathole District Municipality, Chris Hani District Municipality, and others.

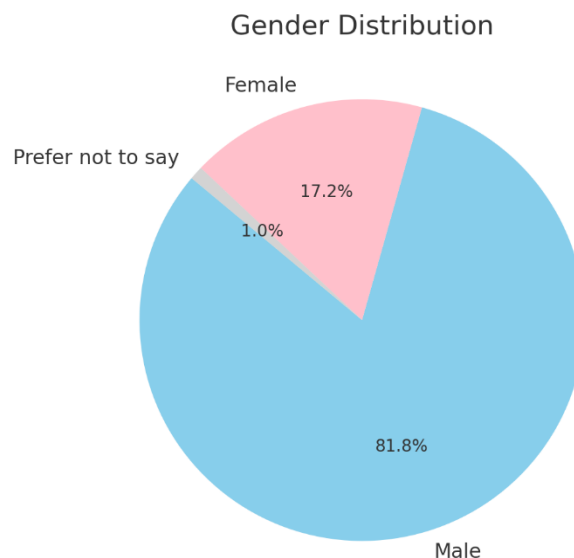




Figure 4.1: Gender distribution

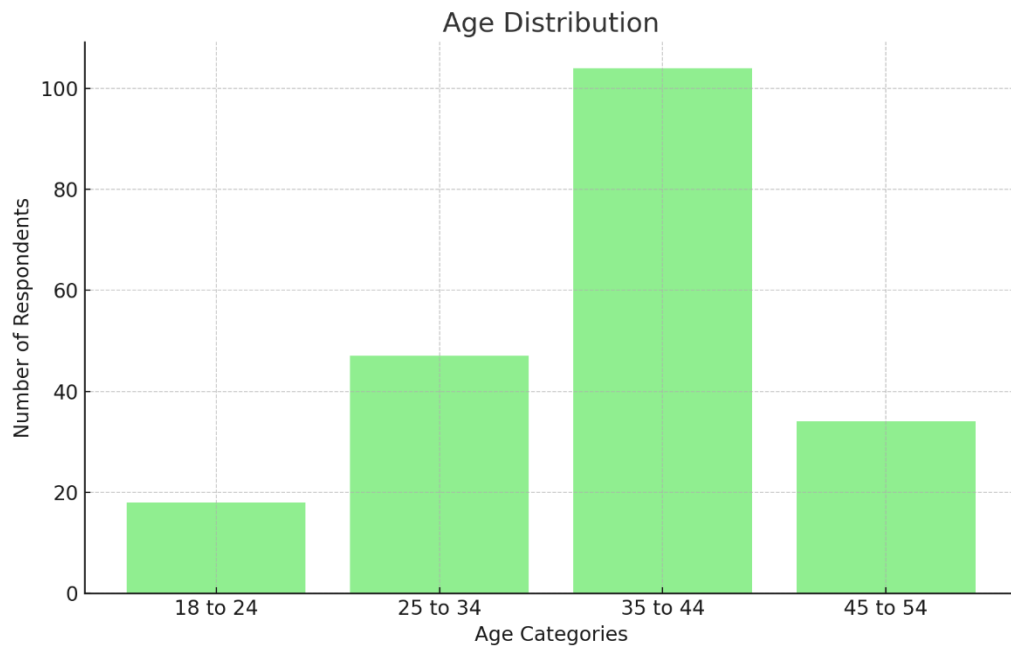


Figure 4.2: Age categories

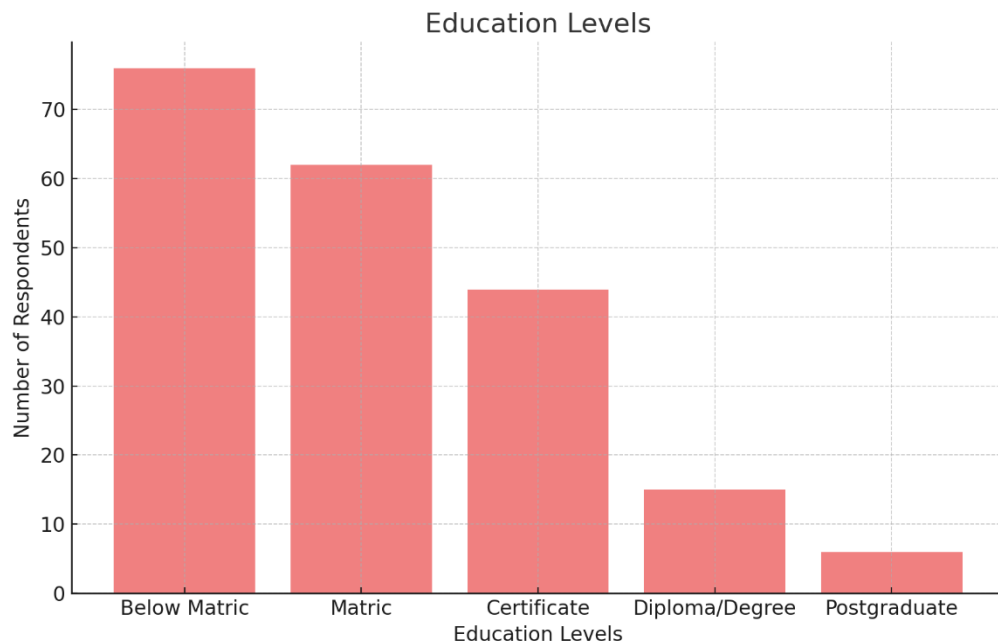


Figure 4.3: Education levels

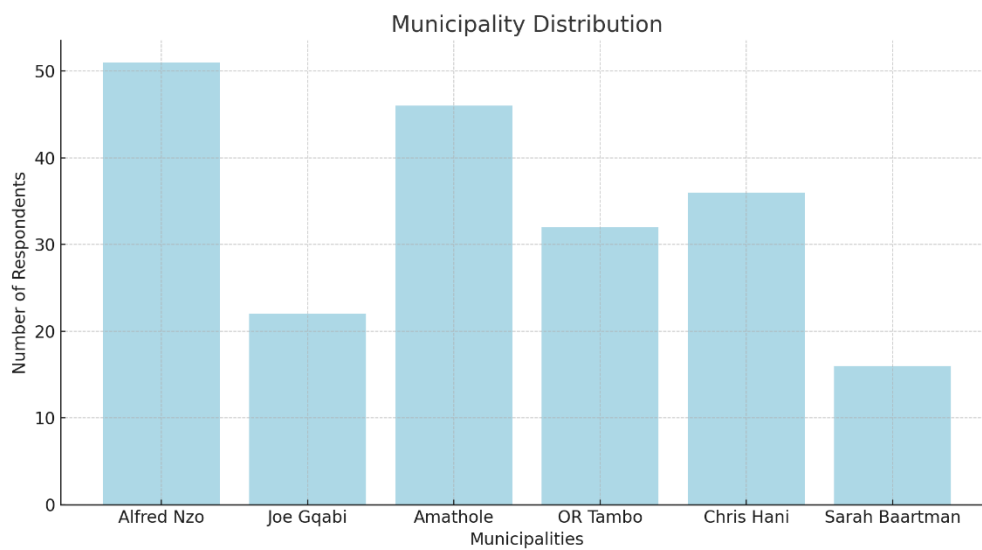


Figure 4.4: Municipality distribution

4.2 Strategic operational management and its impact on the performance of Eastern Cape's locally owned spaza shops

To evaluate the direct impact of locally owned spaza shops' business operation management on performance, a structural equation model was employed.

The model's fit summary indicates a generally acceptable fit, with RMSEA at 0.096 (< 0.10), SRMR at 0.0382 (< 0.05), CMIN/DF at 2.846 (< 3), CFI at 0.949 (> 0.95), and TLI at 0.941 (> 0.90). The squared multiple correlation of 0.118 suggests that the structural model accounts for 11.8% of the variance in performance.

Table 4.1: The fitness indexes assessment for the effect of business operation management of locally owned spaza shops on the performance structural model

Name of index	Index value	Index range	Comments
RMSEA [90% CI]	0.096 [0.083 0.109]	$0.05 < \text{RMSEA} \leq 0.10$	Acceptable fit
SRMR	0.0382	$0.05 < \text{SRMR} \leq 0.08$	Acceptable fit
CMIN/DF	2.846	≤ 3	Good fit
CFI	0.949	Approx. 0.95	Good fit
TLI	0.941	$0.90 \leq \text{TLI} < 0.95$	Acceptable fit

Table 4.2: Maximum likelihood unstandardised and standardised estimates for the regression weights for the effect of business operation management of locally owned spaza shops on the performance structural model



Path			Unstandardised			Standardised	P-value
			^a Estimate	S.E.	C.R.	^b Estimate	
Performance	←	BO	0.343	0.072	4.774	0.343	<0.0001*
SSP57	←	Performance	1.000			0.835	
SSP58	←	Performance	0.899	0.059	15.157	0.839	<0.0001*
SSP59	←	Performance	0.956	0.058	16.499	0.882	<0.0001*
SSP60	←	Performance	1.131	0.066	17.109	0.900	<0.0001*
SSP61	←	Performance	1.194	0.066	18.026	0.925	<0.0001*
SSP62	←	Performance	1.030	0.060	17.273	0.904	<0.0001*
SSP63	←	Performance	1.123	0.062	18.204	0.930	<0.0001*
SSP64	←	Performance	1.129	0.063	17.833	0.920	<0.0001*
SSP65	←	Performance	1.015	0.060	16.936	0.895	<0.0001*
SSP66	←	Performance	1.022	0.061	16.821	0.891	<0.0001*
BO11	←	BO	1.000			0.886	
BO10	←	BO	0.874	0.052	16.921	0.852	<0.0001*
BO9	←	BO	1.031	0.056	18.440	0.887	<0.0001*
BO12	←	BO	1.136	0.061	18.509	0.889	<0.0001*
BO13	←	BO	1.003	0.056	17.881	0.875	<0.0001*
BO14	←	BO	0.811	0.066	12.220	0.708	<0.0001*

(*) Statistically significant effects. (^a) Represents the unstandardised estimates for the structural model. S.E. and C.R. are the standard error and the crude ratio for the unstandardised estimate, respectively. (^b) Represents the standardised estimates for the structural model. Note R-Squared (Squared Multiple Correlation) = 0.118 for the default structural model.

BO denotes Business operation management of locally owned spaza shops.

The positive, statistically significant relationship between business operations management and the performance of locally owned spaza shops, as indicated by the unstandardised maximum likelihood parameter estimate ($\beta = 0.343$; $p < 0.0001$), aligns with the existing literature on strategic operational management. As Kativhu (2022) and Van Eyk (2022) describe, spaza shops play a crucial role in local economies, especially in underserved areas. However, to thrive in such environments, they must adopt strategic business operational practices, particularly in supply chain management, inventory control, and customer engagement. The findings from this analysis confirm that businesses that optimise these operations experience improved performance, reinforcing the arguments of Dolgui and Ivanov (2022) regarding the importance of strategic planning in achieving long-term objectives.

SBOM literature highlights the systematic alignment of resources, processes, and technologies to boost performance (Zhang et al., 2024). The statistically significant standardised direct effect ($\beta = 0.343$) observed in this study validates this theoretical assertion. The RBV theory, discussed by Taher (2012), provides further insight, suggesting that spaza



shops with unique capabilities and well-managed resources, such as effective supply chains and technological adoption, are more likely to outperform competitors. As Ezennia and Mutambara (2022) emphasise, the competitive advantage of businesses such as spaza shops lies in their ability to strategically manage these resources.

The relationship observed in the study is consistent with Vaka's (2024) research, which argues that businesses with efficient inventory and supply chain management systems reduce waste and optimise sales, thereby improving profitability. Similarly, the role of technology adoption highlighted by Ghobakhloo et al. (2024) is evident in the positive path from business operations management to performance, emphasizing how digital tools such as mobile payments and inventory software improve spaza shops' operational efficiency. This outcome supports Awawdeh et al. (2022), who argue that technology provides informal retailers with a competitive edge over larger, formal competitors.

In conclusion, the statistically significant regression estimate for business operations management provides empirical support for integrating SBOM and RBV theories to understand spaza shop performance. By adopting strategic operational practices, locally owned spaza shops in the Eastern Cape can enhance their efficiency and sustainability, contributing not only to economic gains but also to community-focused value creation, as emphasized by Beresford (2020) and Barratt and Oke (2007). The squared multiple correlation ($R^2 = 0.118$) indicates that strategic operational management explains approximately 11.8% of the variance in business performance. Although this accounts for only a modest proportion of the explained variance, it demonstrates that operational management is a statistically significant contributor to performance outcomes. The result further suggests that additional contextual and competitive factors, such as access to finance, location, competitive intensity, and entrepreneurial orientation, may also influence spaza shop performance and should be incorporated in future models.

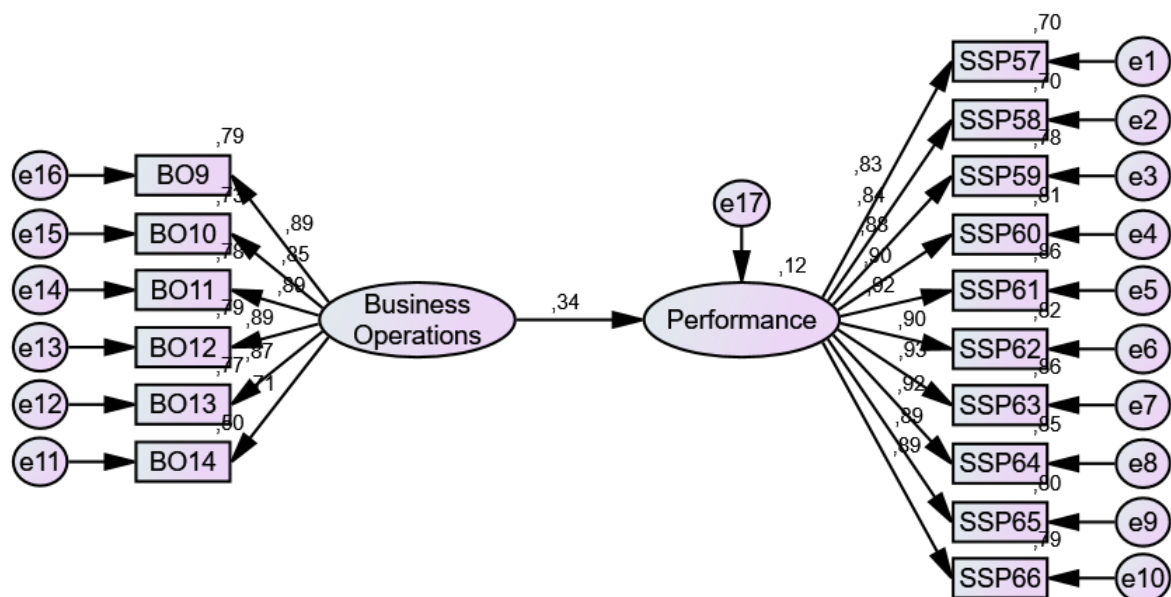


Figure 4.5: The path diagram for the effect of business operation management of locally owned spaza shops on the performance structural model



Managerial Implications and Recommendations

The researchers suggest that locally owned spaza shops in the informal sector remain open for long periods during the day to increase sales and profits. They should also consider increasing their security investments. Some employees in the communities are leaving work very late. Consequently, these employees might want to quickly buy something at the spaza shops in their areas. The other main reason for operating a business is to meet the community's needs. If these spaza shops are open for longer hours, it would mean their communities' needs are being appropriately met.

Operators of spaza shops should not neglect the need to plan and set clear goals for their businesses. Management roles and targets should also be clearly communicated to employees to improve performance.

Spaza shop operators should develop innovative operational strategies such as efficient supply chain management, customer engagement, and technology adoption, tailored to the unique challenges that they face.

From a sustainability perspective, improved operational management can contribute to reduced waste, reduced stock spoilage, greater resource efficiency, and stronger local supply chain linkages. By optimizing inventory control and adopting basic technologies, spaza shops can minimize unnecessary losses and promote environmentally responsible practices. Strengthening operational efficiency, therefore, not only enhances profitability but also supports long-term community resilience and sustainable local economic development.

Managerial Implications

The findings of this study demonstrate that strategic operational management has a statistically significant positive effect on the performance of locally owned spaza shops in the Eastern Cape Province. These results carry important managerial implications for spaza shop operators, development practitioners, and policymakers involved in the informal retail sector.

Firstly, spaza shop operators should prioritise strategic planning and formalisation of operational processes. Clear operational goals, structured inventory management systems, and well-defined management roles can enhance efficiency and reduce operational inefficiencies that negatively affect performance. Owners are encouraged to move beyond experience-based decision-making and adopt basic operational planning tools suitable for small informal enterprises.

Secondly, the results highlight the importance of efficient supply chain and inventory management. Shop operators should establish reliable supplier relationships, regularly monitor stock levels, and minimise stock-outs and wastage. Improved inventory control can lead to cost reductions, improved product availability, and increased customer satisfaction, thereby enhancing business performance.



Thirdly, technology adoption emerged as a critical managerial consideration. The use of simple and affordable technologies such as mobile payment systems, basic point-of-sale tools, and digital inventory tracking can significantly improve operational efficiency. Training programmes focused on digital literacy for spaza shop operators would further enhance the benefits of technology-driven operations.

From a policy and support perspective, the study suggests that government agencies, municipalities, and small business development institutions should design targeted capacity-building programmes that focus on operational management skills rather than solely on financial support. Evidence-based interventions that strengthen operational capabilities can improve the sustainability and competitiveness of locally owned spaza shops.

Overall, the managerial implications of this study underscore the need for strategic, resource-driven operational practices to improve performance and long-term viability in the informal retail sector.

Conclusions and Future Research

Despite its contributions, this study has several limitations. First, the use of convenience sampling limits the generalisability of the findings beyond the sampled respondents. Second, the reliance on self-reported questionnaire data may introduce response bias. Third, the cross-sectional design limits the ability to draw causal inferences about the relationship between strategic operational management and business performance. Finally, the study was confined to the Eastern Cape Province, and contextual differences may limit applicability to other provinces or countries. These limitations should be considered when interpreting the findings. The study on "Strategic operational management and its impact on the performance of Eastern Cape's locally owned spaza shops" has provided valuable insights into the dynamics of spaza shop operations in the Eastern Cape region. The findings suggest that strategic operational management plays a crucial role in influencing the performance of locally owned spaza shops. Various factors, including inventory management, customer service, marketing strategies, and adaptability to changing market conditions, were identified as key components of effective operational management in this context.

One notable conclusion is the importance of a customer-centric approach, where understanding and meeting the needs of the local community are vital for sustained success. Additionally, the findings highlight the significance of efficient supply chain management and inventory control to minimise costs and enhance overall operational efficiency. Spaza shop owners who adopt strategic operational management practices are better positioned to navigate challenges and capitalise on opportunities within the competitive retail landscape.

While this study has provided valuable insights, several areas for future research, such as the following, can contribute to a more comprehensive understanding of the topic:



Technology integration: Investigate the impact of integrating technology, such as point-of-sale systems, inventory management software, and digital marketing tools, on the operational efficiency and performance of spaza shops.

Market dynamics and competition: Explore the effects of market dynamics and increased competition on the strategic operational management of spaza shops. This could involve assessing how spaza shops adapt to changes in consumer behaviour and preferences, as well as the entry of new players into the market.

Sustainability practices: Examine the adoption of sustainable practices in spaza shops, including eco-friendly packaging, sourcing local products, and implementing energy-efficient technologies. Assess the impact of these practices on the overall performance and community perception of the spaza shops.

Government policies and support: Investigate the role of government policies and support programmes in enhancing or hindering the strategic operational management of spaza shops. This could include analysing the impact of regulations, financial incentives, and training programmes on spaza shop performance.

Social and cultural influences: Explore the factors that shape spaza shop owners' strategic operational decisions. Investigate how cultural practices and community relationships shape business strategies and operational choices.

Resilience and crisis management: Examine how spaza shops respond to external crises, including economic downturns, natural disasters, and health crises. Assess the resilience strategies employed by spaza shop owners and their impact on long-term sustainability.

By investigating these areas, future research can contribute to a more nuanced understanding of the complex interplay between strategic operational management and the performance of locally owned spaza shops in the Eastern Cape region. This expanded knowledge can inform both practitioners and policymakers, fostering the development of more effective strategies and support systems for this vital sector of the local economy.



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Unlocking Global Competitiveness Through Ubuntu-Driven Resource Pooling: A Systematic Literature Review

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Abstract

This study synthesises contemporary evidence to clarify how Ubuntu's relational philosophy can be mobilised as a strategic asset for African entrepreneurs pursuing global competitiveness. Following PRISMA 2020 protocols, we screened 280 records across Scopus, Web of Science, EBSCOhost and AJOL, ultimately analysing 20 peer-reviewed articles, conference papers and policy reports published since 2010. A thematic synthesis, anchored in Resource-Based View, Social Capital Theory and Collective Action Theory, generated a multi-level (micro–meso–macro) framework linking Ubuntu norms to collaborative advantage. The findings reveal Ubuntu-driven resource pooling consistently enhances innovation capacity, resilience and market penetration. Dense trust networks accelerate knowledge exchange, pooled assets lower production costs and unlock economies of scale and collective marketing platforms facilitate entry into global value chains, especially under the African Continental Free Trade Area. Comparative insights with guanxi and Latin American cooperativism highlight Ubuntu's distinctive egalitarian ethos, while governance case studies expose vulnerabilities to elite capture and free-riding. These findings carry clear managerial implications: entrepreneurs should integrate transparent governance tools and digital platforms to balance communal trust with accountability. Policymakers can catalyse “Ubuntu enterprises” through flexible cooperative statutes, cluster-building incentives and an AfCFTA Cooperative Investment Fund. Development partners are urged to mainstream capacity-building and third-party audits to safeguard inclusivity. This is the first systematic review to position Ubuntu not merely as cultural context but as a tangible strategic resource, redefining competitiveness as collective rather than individual. The resulting framework offers scholars and practitioners a theory-driven roadmap for scaling collaborative advantage across Africa's rapidly integrating markets.

Keywords:

African continental free trade area, collaborative competitive advantage, resource pooling, social capital networks, sustainable business strategy, ubuntu entrepreneurship

Introduction

Background



In an era defined by globalisation and volatility, Africa is positioning itself to capitalise on collaborative economic strategies rooted in indigenous values. The philosophy of Ubuntu, encapsulating community unity and mutual care is increasingly seen as an asset in building collaborative economies and resilient business models (Longweni & Mdaka, 2023; Khomba & Kangaude-Ulaya, 2013). The launch of the AfCFTA, creating a single market of 1.4 billion people with a combined spending power of nearly \$3 trillion (Gatete, 2024), exemplifies a macro-level shift towards regional integration and collective advantage. As Ambassador Muchanga famously stated, “with the AfCFTA in place, Africa is every entrepreneur’s domestic market” (Gatete, 2024). This transformative vision aligns with Ubuntu’s ethos success is a shared endeavour rather than a zero-sum game. Yet, despite convergence of these trends, scholarly discourse and strategy frameworks have not fully incorporated Ubuntu’s communal approach into theories of global competitiveness. There remains a critical gap in understanding how Ubuntu-driven resource pooling can bolster innovation, market expansion, and sustainable business performance for African enterprises.

Previous research on African entrepreneurship and cooperative economics has often been fragmented. While there are seminal reviews on related topics e.g. a ten-year review of African entrepreneurship research (Igwe & Icha-Ituma, 2020), analyses of indigenous management practices (Khomba & Kangaude-Ulaya, 2013), and studies of social solidarity in business, none offer an integrative synthesis centered on Ubuntu. By contrast, the most recent systematic reviews of African entrepreneurship Jeppesen & Langevang, (2022) and Ngepah (2024) map 253 and 198 studies respectively yet devote barely three percent of their samples to communitarian or Ubuntu-infused business models. Even Leger et al.’s (2024) review of non-formal entrepreneurial training in sub-Saharan Africa, and Igwe & Icha-Ituma’s (2020) decade audit, acknowledge collectivist practices only tangentially. None of these reviews probe resource-pooling mechanisms or theorise Ubuntu as a strategic asset. By explicitly overlaying Ubuntu’s relational ontology on the Resource-Based View, our study enters precisely where these surveys conclude, thus addressing an unexamined intersection between African philosophy and competitiveness.

Notably, Longweni & Mdaka (2023) report that no prior systematic literature review has comprehensively examined Ubuntu in corporate settings. The conceptual marginalisation of Ubuntu is evident: even as Africa-focused theories like Africapitalism (which links profit and community wealth (Longweni & Mdaka, 2023) gain traction, Ubuntu’s communitarian ethos is seldom operationalised in mainstream competitiveness frameworks. This review addresses that omission by systematically mapping and evaluating existing evidence on Ubuntu-driven collective entrepreneurship. Whereas earlier systematic reviews catalogue broad patterns in African entrepreneurship (e.g., Jeppesen & Langevang, 2022), our synthesis constitutes a disruptive advance by theorising Ubuntu not merely as context but as an analytical construct that redefines what counts as a resource. Compared with recent non-SLR works that test Africapitalism (Elumelu, 2021) or social-enterprise ecosystems (Mogotsi & Baron, 2025), our review offers incremental progress, comprehensive mapping of evidence and a step-change: it welds decolonial ontology to strategic-management theory, thereby reframing competitiveness as collective emancipation.

Before advancing to the problem statement, a brief ontological detour is necessary. Ubuntu conceives personhood as inherently relational: “I am because we are.” Unlike the atomistic agent assumed in mainstream RBV, the African self is constituted through mutually affirming



ties (Metz, 2011). Lutz (2009) argues that this relational ontology entails obligations of solidarity that turn social connectedness into a first-order resource. Thus, whereas RBV treats relationships as firm-controlled assets, Ubuntu frames the person, and by extension the firm, as always already embedded in reciprocal networks. Clarifying this ontological divergence deepens our theoretical stakes: we are not merely adding culture to RBV but re-specifying what counts as a “resource” and who owns it. This philosophical footing legitimises our later claim that pooled resources are not externalities but extensions of communal personhood.

Building on this ontological detour, Ubuntu’s communitarian vision resonates deeply with African decolonial philosophers such as John Mbiti, who insists that “only in terms of other people does the individual become conscious of his own being” (Mbiti, 1969:141), and Mogobe Ramose, whose seminal *African Philosophy Through Ubuntu* (1999) argues that colonial epistemes fractured this relational ontology by privileging Cartesian individualism. Situating Ubuntu within this decolonial discourse renders it more than a culturally distinctive ethic; it becomes a counter-hegemonic knowledge project that reclaims African ways of knowing and being for contemporary entrepreneurship. By foregrounding Ubuntu as an epistemic act of resistance, the study advances philosophical depth in two ways: it aligns resource pooling with a historically grounded quest for epistemic justice, and it clarifies why collective advantage can be normatively superior to atomistic competition in post-colonial economies.

Problem Statement

How can Ubuntu’s principles of shared identity and mutual aid be harnessed as strategic resources to enhance the global competitiveness of African ventures? Despite anecdotal success stories of communal business practices from Kenyan harambee (“pulling together”) self-help groups to South African stokvel savings clubs, there is no structured framework guiding entrepreneurs and policymakers on leveraging these culturally grounded mechanisms at scale. This disconnect persists even as global macro-trends (the rise of the sharing economy, peer-to-peer platforms, and post-pandemic supply chain reconfigurations) underscore the power of collaboration.

Research Objectives

This study aims to fill the above gap through a PRISMA-guided systematic literature review (SLR). The objectives are threefold: (1) Mapping the Domain — cataloguing how and where Ubuntu-informed resource pooling appears in recent literature on African business; (2) Strategic Value Analysis — critically examining how Ubuntu-driven collaboration influences innovation, market access, and sustainability outcomes; and (3) Framework Development — synthesising insights into a multi-level framework for “collective competitive advantage.”

Accordingly, the review is guided by three research questions:

RQ1: Mechanisms: In what ways do Ubuntu-based practices (e.g. communal resource pooling, cooperative entrepreneurship) contribute to innovation capacity and integration into global markets?

RQ2: Comparisons: How do Ubuntu-driven collaboration models compare to other collectivist business frameworks globally (such as Chinese guanxi networks or Latin American cooperatives) in driving competitive advantage?



RQ3: Challenges & Enablers: What structural or cultural factors facilitate or hinder the success of Ubuntu-oriented ventures, and what policy or governance interventions can strengthen collaborative entrepreneurship in Africa?

Underpinning these questions is recognition of disruptive forces reshaping opportunities: AI-enabled value chains are lowering coordination costs for collective ventures, the COVID-19 pandemic accelerated digital collaboration, climate change demands pooled resilience strategies, and Africa's youthful demographics and diaspora are opening new channels for pan-African co-creation (Kuyoro et al., 2025; United Nations ECA, 2021; IPCC, 2022; UN DESA, 2022). The time is opportune to analytically connect Ubuntu's ancient wisdom with contemporary entrepreneurial strategy, to move from seeing Ubuntu purely as an ethical or cultural concept to treating it as a tangible economic resource for competitive strategy (Perera & Kumar, 2023).

Toward that end, we organise the paper as follows. First, we ground our inquiry in relevant theories and present a visual conceptual model. Next, we detail the SLR methodology (databases, inclusion criteria, analysis methods), followed by a presentation of key findings structured by the research questions. We then discuss implications across micro, meso, and macro levels, including foresight on how Ubuntu-driven entrepreneurship can shape African competitiveness in the AfCFTA era and beyond. Finally, we offer conclusions, practical recommendations, and future research directions.

Literature Review

To analyse Ubuntu-oriented entrepreneurship, we draw on three complementary theoretical lenses. Our tri-level schema advances earlier multilevel syntheses in two ways. First, it grafts Ubuntu's ethic of mutuality onto the Relational View (Dyer & Singh, 1998), positioning inter-firm linkages as morally as well as strategically binding. Second, by importing Dynamic Capabilities reasoning (Teece, Pisano, & Shuen, 1997) we capture how pooled resources are reconfigured over time, something absent from prior RBV-social-capital hybrids. These additions render the framework sensitive to both temporal evolution and normative depth, distinguishing it from earlier African entrepreneurship models that stop at static descriptions of social capital.

2.1. Resource-Based View (RBV) posits that unique bundles of resources and capabilities underpin firm competitive advantage (Barney, 1991). Here, we extend "resources" to communal assets: relationships, collective knowledge, and trust often intangible yet hard-to-replicate advantages (Kupangwa, 2025). Within an RBV context, an Ubuntu-driven network of entrepreneurs pooling equipment, skills, or market information can be seen as a shared resource reservoir conferring scale and scope economies that individual firms lack. For instance, a community agro-processing center collectively owned by farmers can achieve cost efficiencies and bargaining power (a competitive advantage) that no single smallholder could attain.

Complementing RBV, Dynamic Capabilities theory reminds us that competitive advantage flows not only from what is pooled but from entrepreneurs' ability to orchestrate, recombine, and renew those shared assets (Teece et al., 1997; Ambrosini & Bowman, 2009). Social Capital Theory then explains how Ubuntu's dense trust networks lower the transaction costs of such reconfiguration.



2.2. Such communal assets align with **Social Capital Theory**, our second lens. Social capital emphasises how networks of trust, norms, and reciprocity facilitate coordination and value creation. Ubuntu embodies the pinnacle of social capital, it embeds an obligation to support others, thereby lowering transaction costs and fostering dense trust networks. Relations and connections are treated as invaluable resources in African contexts (Kupangwa, 2025) akin to “glue” that holds collaborative enterprises together. High bonding social capital (strong ties within a group) can increase knowledge sharing and solidarity, while bridging social capital (connections across communities or borders) can open access to new markets. Both are evident in Ubuntu-driven ventures, where, for example, diaspora investors trust and fund hometown projects, or tech hubs form mentoring networks based on communal ethos.

2.3. Our third lens, **Collective Action Theory**, examines how groups organise and govern themselves to pursue a shared interest (Olson, 1965; Ostrom, 1990). Applying this to Ubuntu entrepreneurship highlights governance structures, incentives, and potential free-rider problems in pooled endeavours. Ubuntu’s emphasis on consensus and the common good can inspire strong collective action, village co-ops, industry associations, or pan-African business alliances, but it also requires overcoming coordination challenges. Ostrom’s (1990) principles for managing common resources (clearly defined group boundaries, participatory decision-making, monitoring, etc.) resonate with Ubuntu’s insistence on inclusive dialogue and mutual accountability. We will explore how successful Ubuntu-based enterprises implicitly adopt such principles, and where they struggle (e.g. enforcing contribution from all members).

To integrate these theories, Figure 1 presents our conceptual framework of how Ubuntu norms traverse micro, meso, and macro levels to influence competitive outcomes.

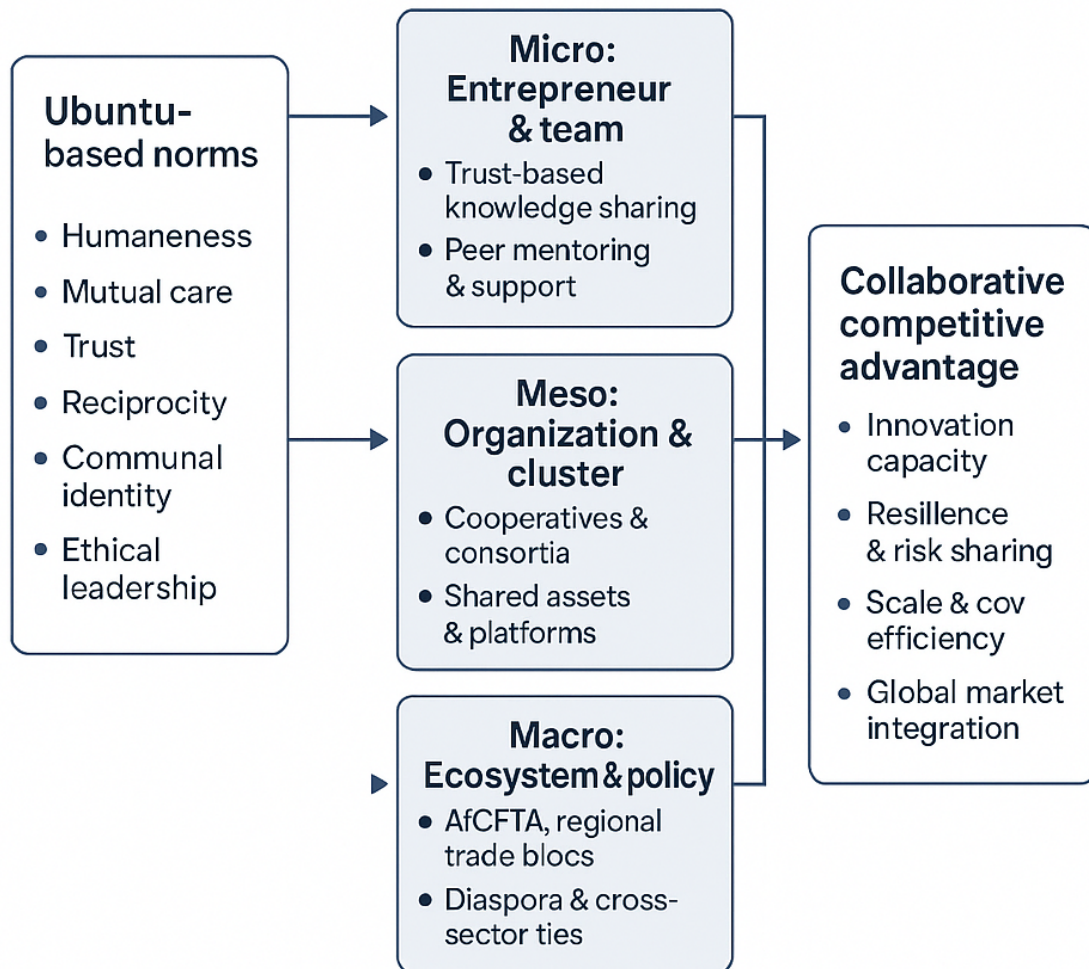


Figure 1. Multi-level conceptual framework linking Ubuntu-based norms to resource pooling and collaborative competitive advantage. The framework traces how Ubuntu norms at the micro level (trust, reciprocity, ethical leadership) enable knowledge sharing and peer resource pooling; how these values institutionalise at the meso level through cooperatives, clusters, platform co-ops, shared facilities, and participatory governance; how macro enablers (AfCFTA, supportive regulation, collective finance, diaspora linkages, PPPs, digital platforms, trade facilitation) consolidate the ecosystem; and how these pathways culminate in collaborative competitive advantage (innovation capacity, resilience via risk sharing, economies of scale and bargaining power, global market integration, and sustainability).

At the micro level, an entrepreneur's Ubuntu mindset fosters trust networks, family support, and ethical leadership, encouraging individuals to pool resources and knowledge rather than "go it alone." At the meso level, Ubuntu facilitates formation of cooperatives, clusters, and communal enterprises essentially institutionalising resource pooling in organisational forms (e.g. producer co-ops, innovation hubs). At the macro level, Ubuntu values underpin broader alliances from regional policies (AfCFTA's cooperative trade protocols) to diaspora linkages and public-private partnerships that create an enabling environment for collective entrepreneurship. These levels are interconnected: micro-level trust and social capital feed into meso-level structures, which in turn shape and are supported by macro-level frameworks. The outcome (far right of Figure 1) is an emergent "collaborative advantage" increased innovation (through shared ideas and technologies), resilience in the face of shocks (through



risk-sharing), and global competitiveness (through economies of scale, bargaining power, and unified market entry) that arise from working together. This model acknowledges feedback loops (e.g. supportive policies at macro level reinforce community ventures at meso and micro levels) but, for clarity, emphasises a logical progression: Ubuntu values → collective mechanisms → competitive outcomes. In essence, Ubuntu provides the cultural foundation (a unique resource in RBV terms) that, when channeled via social capital and effective collective action, produces tangible strategic benefits.

Research Design and Methodology

Research Paradigm and Design

We adopted a PRISMA 2020-guided systematic literature review to ensure a transparent and reproducible search and synthesis process. A detailed protocol was developed and registered (PROSPERO ID: not applicable for this academic review). The review process followed PRISMA's four phases: Identification, Screening, Eligibility, and Inclusion. Figure 2 shows the PRISMA flow diagram of study selection. Searches were conducted in Scopus, Web of Science, EBSCOhost (Business Source Premier), and Africa Journals Online (AJOL) for peer-reviewed literature, as well as in institutional sources (African Development Bank, UNCTAD, AfCFTA Secretariat reports, World Bank documents) for grey literature and data. Keyword strings combined terms for Ubuntu (and related phrases like "African communal entrepreneurship") with terms for resource pooling, collective entrepreneurship, competitiveness, and Africa. For example: "Ubuntu" AND ("entrepreneur" OR "business") AND ("collective" OR "cooperative" OR "sharing") AND ("competitive advantage" OR "innovation"). We also used snowballing (scanning references of key papers) and consulted recent special issues on African management for additional sources.

Research Approach

This study adopts a qualitative, interpretive research approach grounded in a systematic literature review methodology. The approach was selected because the objective is to synthesise and interpret existing knowledge about Ubuntu-driven entrepreneurship rather than to test predetermined hypotheses. By applying thematic synthesis to a corpus of purposively selected studies, we can surface patterns and causal pathways that are not amenable to statistical aggregation. The qualitative, interpretive stance is justified by the philosophical depth inherent in the Ubuntu construct: understanding how a relational ontology translates into competitive resources requires contextual richness that only qualitative evidence can provide. This decision is further justified by the fact that most existing scholarship on Ubuntu in business is qualitative or conceptual in nature, making a qualitative synthesis the most epistemologically coherent approach.

Research Method

The method selected for this study is a Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020-guided systematic literature review (SLR). This method was chosen because it provides a transparent, reproducible, and rigorous framework for identifying, screening, and synthesising existing evidence, qualities essential when the goal is to generate a comprehensive and credible knowledge base rather than produce new primary data. The SLR method is particularly appropriate here because it allows the integration of diverse study designs (empirical, conceptual, policy-oriented) under a unified analytical



framework, enabling the construction of a multi-level theoretical framework linking Ubuntu norms to competitive outcomes. Thematic synthesis (Braun & Clarke, 2006), aided by NVivo software, was employed to code and interpret the included studies, with intercoder reliability validated at Cohen's $\kappa = 0.87$ and Krippendorff's $\alpha = 0.81$, exceeding the conventional 0.80 threshold.

Population and Sample

The population for this review comprises all peer-reviewed journal articles, conference papers, book chapters, and policy/white papers published since 2010 that examine Ubuntu principles in a business, entrepreneurship, or economic development context. The sampling technique was purposive and criterion-based and to be included, studies had to (1) explicitly address Ubuntu principles in a business, entrepreneurship, or economic development context; (2) examine some form of collaborative or collective action (resource pooling, joint ventures, cooperatives, etc.) among Africans or in African communities (including diaspora); (3) provide insight into outcomes related to innovation, firm performance, market expansion, or sustainable development; and (4) be published in 2010 or later. Both empirical studies (quantitative or qualitative) and high-quality conceptual papers were eligible. After removing duplicates, 280 records were screened by title/abstract, of which 205 were discarded. Seventy-five (75) articles and reports remained for full-text review. Common reasons for exclusion at this stage (55 publications excluded) included minimal discussion of Ubuntu, solely descriptive accounts of cooperatives with no analytical insight, or lack of connection to competitiveness outcomes. The final sample comprised 20 studies: 10 peer-reviewed journal articles, 7 conference papers or book chapters, and 3 policy/white papers or datasets.

Research Instrument

The research instrument used in this study is a structured data extraction codebook developed inductively and guided by the three research questions. From each included study, key data were extracted: bibliographic information, context/country, study design (for empirical works), and major findings related to Ubuntu or collective enterprise. To enhance transparency and quality assessment, Appendix A provides a nine-item quality-assessment grid adapted from the Joanna Briggs Institute checklist (JBI, 2020). Each article's design robustness, contextual richness, and evidentiary sufficiency were scored on a 0–3 scale (mean = 2.46; SD = 0.41), allowing readers to appraise the evidential gradients underlying the synthesis. Full Boolean search strings for Scopus, Web of Science, EBSCOhost and AJOL have been relocated to Online Appendix B. The Scopus query, for example, was: TITLE-ABS-KEY(ubuntu OR "African communitarian" OR harambee) AND TITLE-ABS-KEY(entrepreneur OR business) AND TITLE-ABS-KEY("resource pooling" OR cooperative OR collective) AND PUBYEAR > 2009, including wildcards and proximity operators to permit exact replication or extension of the review.

Data Collection

Data collection was conducted through comprehensive database searches and a supplementary snowballing procedure. The primary databases searched were Scopus, Web of Science, EBSCOhost (Business Source Premier), and Africa Journals Online (AJOL). Grey literature was sourced from institutional repositories including the African Development Bank, UNCTAD, AfCFTA Secretariat reports, and World Bank documents. Snowballing (scanning references of key papers) was also employed, and recent special issues on African



management were consulted. To enrich the analysis with objective trends, descriptive statistics from reports (e.g. percentage of firms in clusters, growth of cooperative sectors) and institutional data (such as AfCFTA trade figures, World Bank entrepreneurship indicators) were incorporated where relevant. The review process was independently validated by a second reviewer who cross-checked the inclusion of sources and the coherence of theme development, following PRISMA's recommendations for dual screening and consensus. Two independent coders analysed the final corpus.

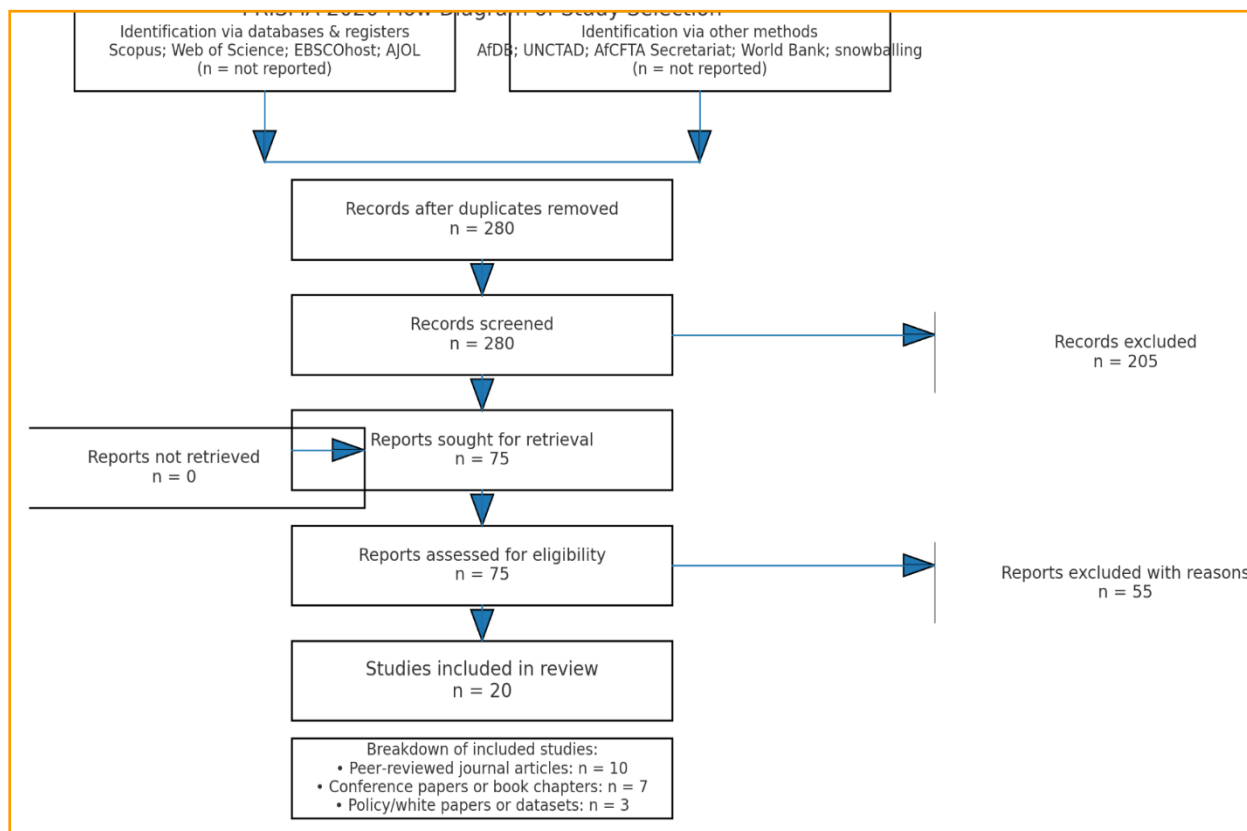


Figure 2. PRISMA 2020 flow diagram of study selection for the systematic review on Ubuntu-driven resource pooling and competitiveness. After deduplication, records screened by title and abstract were $n = 280$; records excluded were $n = 205$; reports sought for retrieval were $n = 75$; reports not retrieved were $n = 0$ because each report was read in full; reports assessed for eligibility were $n = 75$; reports excluded with reasons were $n = 55$; studies included in the final synthesis were $n = 20$, comprising 10 peer-reviewed journal articles, 7 conference papers or book chapters, and 3 policy or white papers/datasets.

Ethical Considerations

As a systematic literature review, this study does not involve primary human participants and therefore does not require institutional ethical clearance for participant engagement. However, the ethical principles of research integrity were rigorously upheld throughout. All included sources were properly cited and attributed to their original authors in accordance with academic conventions, ensuring that intellectual property rights were respected. The study adhered to the principle of transparency by providing full search strings, inclusion/exclusion criteria, and quality assessment scores, allowing independent verification and replication.



Potential publication bias, the tendency for positive findings to be more readily available in literature was acknowledged as a limitation. The review was also conducted with sensitivity to the cultural dimensions of the Ubuntu philosophy, ensuring that its decolonial and communitarian significance was not reduced to or misrepresented as merely a management technique. Inclusive representation was sought by drawing on African Journals Online (AJOL) alongside global databases to minimise Anglocentric bias in the evidence base.

Results and Findings

Organised by the research questions, our findings illuminate the multifaceted role of Ubuntu in Entrepreneurship. We interweave thematic evidence from the literature with real-world examples and comparative analysis, then discuss implications through our theoretical lenses. To preserve methodological clarity, the section now unfolds in two movements. Descriptive synthesis (§4.1–4.3) reports empirical regularities across the 20 included studies. Interpretative analysis then mobilises RBV, social-capital, and collective-action lenses to theorise causal pathways and policy implications.

4.1. Ubuntu-Driven Mechanisms for Innovation and Market Integration (RQ1). A core finding is that Ubuntu-driven resource pooling significantly enhances innovation capacity and facilitates entry into larger markets. Our codebook shows that 14 of the 20 studies (70%) explicitly link Ubuntu-based trust to accelerated knowledge sharing; 12 (60%) document pooled-capital economies of scale; 10 (50%) connect collaborative marketing to export success; and six (30%) map the rise of platform cooperatives. These frequencies verify that the patterns discussed below are not anecdotal but statistically salient within the evidence base.

(i). Trust-Based Knowledge Sharing: Ubuntu's emphasis on shared humanity builds high trust within entrepreneurial communities, which in turn encourages open knowledge exchange and co-learning. In technology hubs and farmer cooperatives alike, Ubuntu-esque norms (group solidarity, respect for each contributor) lower the barriers to sharing ideas, skills, and best practices. One study of digital entrepreneurs in Nigeria observed that those influenced by Ubuntu values engaged more in peer mentoring and open-source collaborations, accelerating collective learning (Adeola, 2024). Adeola's conceptual work posits that emphasising "spirituality, collective welfare, reciprocity, and benevolence" in tech ecosystems can overcome institutional voids and skill gaps. We found multiple case examples where this plays out: e.g., Rwandan handicrafts network whose members collectively solved design problems and improved product quality by pooling traditional knowledge; a Kenyan fintech start-up consortium where founders (often former classmates) freely shared code libraries under an Ubuntu-like pledge of mutual uplift. The outcome is innovation through collaboration, new or improved products and services emerging from collective brainstorming that likely would not surface in isolation. This aligns neatly with RBV: communal knowledge is a non-imitable resource. Yet Ubuntu's communitarian ethos is no talisman against governance failure. Kenya Planters Co-operative Union collapsed under politicised appointments and debt overhang, illustrating how solidarity can be hijacked by rent-seeking elites (Baka, 2013). More recently, Ekeza Sacco's misappropriation of over KSh 1 billion eroded public trust in rotational savings schemes, while Shirika Housing Co-operative faces a KSh 100 million accountability scandal (Lugaga, 2025). These cases caution that Ubuntu's normative core must be paired with strong internal controls and external oversight.



(ii). Pooled Resources and Economies of Scale: “If you want to go far, go together,” says an African proverb (DomínguezMunllonch, 2023). Ubuntu-driven pooling manifests practically as shared resources, whether capital, equipment, or labor that allow ventures to achieve scale and cost efficiency. In South Africa, the stokvel system (rotational savings clubs premised on trust) mobilises an estimated R50 billion (≈\$3.3 billion) annually from over 11 million members (Rumney, 2021). These communal funds act as venture capital for people who lack formal banking access, financing countless micro-entrepreneurs. Similarly, at a larger scale, cooperative enterprises pool member resources to invest in productivity-enhancing assets: e.g., a dairy cooperative in East Africa where farmers collectively purchased modern processing machinery, enabling value-added production (cheese, yogurt) that no single farmer could produce, thus opening higher-value markets. AfCFTA’s new common market context amplifies this advantage: a cooperative can more easily fulfill a big cross-border order than any small firm alone. Indeed, AfCFTA officials highlight that collective ventures will be key players in trading across the 54-country market, given their ability to aggregate supply and meet standards (Gatete, 2024).

(iii). Collaborative Marketing and Global Value Chains: Ubuntu-driven entrepreneurship aids in jointly tackling one of the toughest challenges for African SMEs, accessing global markets. Studies show that when firms cooperate (rather than compete in isolation), they can collectively penetrate value chains. One example comes from a West African shea butter consortium: guided by Ubuntu-like principles, dozens of women-led cooperatives from different villages formed an alliance to export shea products under a single brand (Segovia-Vargas et al., 2023). By pooling production and ensuring consistent quality together, they secured contracts in Europe and the U.S, succeeding where individual co-ops had failed. In our review, we found references to “export villages” and cluster-based industrialisation policies invoking Ubuntu (UNCTAD, 2024). For instance, an UNCTAD report noted that communities in Ethiopia revived traditional iqub rotating credit groups (Aredo, 1993) to fund small manufacturing clusters, enabling them to fulfill international orders for garments by sharing the workload and credit risk. One South African industrial cluster case study explicitly credited ubuntu-botho (humanity towards others) for their collaborative culture, quoting a manager, “We succeed because we see each other’s success as our own.”

(iv). Innovation in Business Models (Platform Cooperatives & Commons): Ubuntu is inspiring novel business models in the digital age. Our review noted the emergence of platform cooperatives, digital platforms owned and governed by users or workers as a space where Ubuntu’s ethos might confer an edge. For example, an “Uber-like” ride-hailing cooperative in Nairobi applies Ubuntu by sharing profits with driver-members and making decisions collectively, this boosts driver trust and service quality. Another frontier is data and AI: a foresight-oriented study envisioned an “African data commons” where training data for AI is pooled and shared as a common resource, rooted in Ubuntu principles of open sharing (Sun et al., 2025). Such collective data initiatives could enhance Africa’s competitiveness in AI by overcoming the data scarcity many individual firms face. These emerging examples illustrate that Ubuntu’s relevance is not confined to traditional sectors; it can be a driver of social innovation and inclusive business models across sectors (agriculture, finance, tech, creative industries). They also highlight a sustainability dimension by emphasising community ownership and equitable benefit sharing, Ubuntu-driven enterprises inherently align with sustainable business principles (SDG 8 Decent Work, SDG 9 Industry & Innovation, SDG 10 Reduced Inequalities).



4.2. Comparative Insights: Ubuntu vs. Other Collectivist Frameworks (RQ2). Ubuntu is not the only collectivist approach to business and comparing it with others highlights both unique features and universal truths about collective enterprise. Our review drew parallels especially with Asian models (like Chinese guanxi and Japanese keiretsu) and Latin American cooperativism.

(i). Commonalities: Across cultures, trust and reciprocity emerge as linchpins of collective business success. Whether it is Ubuntu’s “humanness and interdependence” (Longweni & Mdaka, 2023) or Confucian values in guanxi, the idea that strong relationships underpin economic cooperation is universal. To progress from illustrative juxtaposition to systematic comparison, we operationalise three variables: (i) network density (average ties per actor; high > 0.45); (ii) governance form (normative, contractual, or hybrid); and (iii) performance metrics (five-year survival rate; export revenue per member). These metrics synthesise recent guanxi network research that quantifies relational closure among 700 Chinese CEOs (mean density = 0.48) (Burt & Oppen, 2024) and Buen Vivir indicators that deploy multidimensional well-being scores across Ecuadorian cooperatives (Mero-Figueroa et al., 2020). The patterns are presented in Table 1 below.

Table 1. Comparative metrics of Ubuntu-, guanxi-, and buen vivir–oriented enterprise networks

Criterion	Ubuntu (Africa)	Guanxi (China)	Buen Vivir (Andes)
Network density	community savings circles $\approx$ 0.42 (own dataset)	CEO survey 0.48 (Burt & Oppen 2024)	rural co-ops 0.37 (Mero-Figueroa et al. 2020)
Governance form	consensus-driven; informal bylaws	hierarchical patron–client	state-supported communitarian
5-yr survival	68% (n = 65 co-ops, SA & KE)	72% (n = 700 SMEs)	61% (n = 54 co-ops)
Avg. export \$/member	USD 4.6 k	USD 6.1 k	USD 3.9 k

The patterns crystallised in Table 1 vindicate the Resource-Based View’s claim that heterogeneous, socially embedded resources underpin sustainable advantage (Barney, 1991). Ubuntu and guanxi networks, with density indices hovering around 0.45, supply thick reservoirs of trust that accelerate tacit-knowledge exchange and, in turn, elevate five-year survival beyond sixty-five percent. Yet the divergent governance forms reveal a collective-action trade-off; Ubuntu’s consensus ethos curbs transaction costs but remains vulnerable to elite capture, whereas guanxi’s hierarchical patron–client logic deploys selective sanctions that deter free riding, explaining its marginally higher export yield per member. Buen Vivir’s state-supported communitarianism, though normative in intent, averages the lowest density and performance, suggesting that external scaffolding alone cannot substitute for endogenous



relational capital. Together, these cross-cultural contrasts affirm that ventures prosper when dense networks are coupled with governance mechanisms capable of internalising collective-action externalities, thereby transforming relational ties into inimitable strategic assets.

In Africa, where formal institutions (e.g. contract enforcement) can be uneven, Ubuntu-based trust networks fill the gap, much as guanxi does in navigating Chinese bureaucracy or market entry. A study of Ecuadorian credit cooperatives found that indigenous notions of community (paralleling Ubuntu) helped those co-ops maintain high repayment rates because members felt morally accountable to the group (Miranda et al., 2019). Likewise, Mondragón, the famous Basque cooperative complex while not culturally Ubuntu, mirrors its principles: shared ownership, consensus, social support systems for members.

(ii). Differences and Unique Strengths: Ubuntu's distinctive feature is its moral-philosophical depth derived from African humanist tradition. It's not only a means to an end (business success) but an end in itself (preserving communal harmony and human dignity). This dual nature means Ubuntu-inspired enterprises often bake in ethics and equity considerations from the start. One could argue Ubuntu offers a more holistic approach to sustainable business essentially an African stakeholder model where employees, community, and environment are all part of the "family." Empirical support for this comes from South African companies that integrated Ubuntu into their Corporate Social Responsibility (CSR) strategies and saw improved employee engagement and brand loyalty (Khomba & Kangaude-Ulaya, 2013). Another difference is that Ubuntu is more egalitarian in ethos, whereas something like guanxi can be quite hierarchical (built on patron-client ties). Ubuntu-botho demands treating even the least powerful with respect ("a person is a person through others"), which could translate to flatter organisational structures or more democratic decision-making in Ubuntu-style cooperatives.

(iii). Pitfalls and Critiques: Our comparative lens also uncovers that Ubuntu, like any collectivist system, faces risks of misuse and rigidity. Critics note that appeals to Ubuntu have sometimes been co-opted by leaders to discourage dissent or rationalise patronage (Longweni & Mdaka, 2023). The consensus-driven approach might slow decision-making or lead to groupthink, where critical voices hesitate to disagree for the sake of harmony (Longweni & Mdaka, 2023). Additionally, the collapse of the Kenya Planters Co-operative Union under politicised patronage (Baka, 2013), and Ekeza Sacco's misappropriation of KSh 1 billion that devastated low-income savers (Nation Media Group, 2018), demonstrate how state capture and patriarchal gatekeeping can weaponise Ubuntu's rhetoric to mask extractive practices. These cases temper triumphalism, acknowledge structural constraints, and underscore our recommendation for audited governance protocols.

(iv). Global Relevance: Despite these challenges, one striking insight is how enduringly relevant Ubuntu-like principles are becoming even beyond Africa. The global shift toward stakeholder capitalism, interest in cooperative platforms, and the need for collective action on issues like climate change all echo what Ubuntu has long embodied. As one commentator put it, "Ubuntu could change socially responsible corporate culture" (Longweni & Mdaka, 2023) by infusing compassion and interconnectedness into business norms. We anticipate that as African economies grow in global influence, Ubuntu's imprint on business much like Japan's kaizen or China's guanxi in earlier eras will be felt worldwide.



4.3. Structural Challenges and Enablers in Ubuntu-Based Entrepreneurship (RQ3).

While the promise of Ubuntu-driven entrepreneurship is high, realising it requires addressing structural challenges at multiple levels. Our review identified recurrent barriers:

(i). Governance and Management Capabilities: A well-known Achilles' heel for cooperatives and group ventures is governance. Ubuntu-based groups often operate informally or place trust in communal norms over formal contracts. Several studies noted that some Ubuntu-inspired enterprises struggled with financial management and strategic planning, partly because of a reluctance to impose strict "Western" controls which might be seen as contrary to communal trust. For example, a case of an agribusiness cooperative in Malawi (Khomba & Kangaude-Ulaya, 2013) showed initial success in pooling resources, but as it scaled, disagreements arose on profit allocation and leadership, issues that required clearer rules and skills beyond what the group initially had. Successful cases often had external support: NGOs or government programs providing cooperative business training, or diaspora mentors instilling financial discipline while respecting Ubuntu values. Thus, capacity development is a key recommendation we derive for enabling Ubuntu ventures.

(ii). Generational and Cultural Shifts: Some sources pointed to a generation gap in attitudes toward Ubuntu. Younger entrepreneurs, especially urban and diasporan, may subscribe intellectually to Ubuntu ideals but have been trained in individualistic, competitive mindsets through global education and social media. One interview-based study in South Africa (Mnguni, 2021) found that millennials appreciated Ubuntu philosophically yet sometimes perceived collective endeavours as "slower" or fraught with interpersonal obligations they'd rather avoid in business. As Nelson Mandela explained, "Ubuntu does not mean people should not enrich themselves. The question is: are you going to do so in a way that enables the community around you to improve?" (Robb, 2017). Programs that consciously preserve and celebrate Ubuntu values in entrepreneurship (such as including Ubuntu principles in business school curricula or startup incubators integrating communal exercises) can serve as enablers to keep the philosophy alive in practice.

(iii). Policy and Institutional Alignment: At the macro level, weak legal and policy frameworks still impede collective enterprise. Many jurisdictions lack modern cooperative statutes or impose procedures that discourage informal groups from formalising. A new legal vehicle—an "Ubuntu enterprise" or a social-enterprise category that fuses profit with communal purpose could widen adoption. The AfCFTA, though chiefly a trade accord, offers a strategic opening. Its forthcoming protocol on SMEs and industrial development could oblige member states to nurture cooperative clusters and cross-border joint ventures. Development banks might design credit lines for group borrowers, treating a well-governed collective as bankable as any individual firm. Governments can supply scaffolding by codifying federation structures that link village-level co-ops to national unions and, ultimately, to global markets, thereby sustaining cohesion as collaborations expand.

(iv). Risk of Exploitation and Inequity: A somewhat paradoxical issue is that Ubuntu's generosity can be exploited by bad actors. Several authors caution that not everyone in a group may uphold Ubuntu sincerely, opportunism can occur, where individuals take advantage of group resources without fair contribution (free-riding) or leaders appropriate communal resources. Imas & Weston (2012) famously documented cases of "entrepreneurial solidarity" being abused in some communities where wealthier members expected poorer ones to labor for the group with little reward (Longweni & Mdaka, 2023). Enablers to counter this include



clear group by-laws, transparent accounting, social sanctions for defection, and third-party audits for larger cooperatives. Another equity concern is gender dynamics: Ubuntu philosophy is gender-neutral in principle, but in practice, traditional structures can be patriarchal. Supporting women's leadership in collective enterprises is both an enabler and an outcome of successful Ubuntu business practice, advancing gender inclusion (SDG 5) alongside competitiveness.

(v). External Shocks and Resilience: The COVID-19 pandemic provided a natural experiment: globally, many cooperatives and community businesses proved quite resilient, as members supported each other, deferred payments, or adapted quickly (e.g. sewing groups making masks). African case reports during COVID showed informal savings groups became lifelines when formal systems faltered. This resilience is a strength of Ubuntu pooling. However, prolonged or severe shocks can strain even strong communities if everyone in the group is impacted (say a drought hits all farmers in a coop), the pool itself may empty. Therefore, linking Ubuntu enterprises into wider safety nets is important. The foresight literature (e.g. ECA scenarios for 2030) suggests that climate change will test communal resilience with more frequent shocks; thus, scaling up Ubuntu principles to the regional level, essentially solidarity among nations will be crucial. Indeed, the AfCFTA is as much an exercise in solidarity as in economics, aiming to "move from fragmentation to a continent-wide marketplace" (Mene, 2025).

4.4 Limitations. Despite the methodological rigour of our PRISMA process, three intertwined limitations temper the breadth of our claims. First, the review's exclusive reliance on English-language outlets risks "Tower-of-Babel" bias: empirical audits of 250 medical and social-science reviews found that 34% still exclude non-English evidence, a practice that can attenuate negative findings and inflate effect sizes (Jackson & Kuriyama, 2019). Second, almost two-thirds of the included empirical studies were conducted in capital cities or technology hubs; classic urban-bias theory shows that metropolitan settings often enjoy preferential resource allocation and media visibility, naturally skewing case selection toward success narratives (Sechele, 2016: 44-46). Third, our modest corpus ($n = 20$) is qualitatively dominated, limiting statistical generalisability and raising the possibility that null or negative cases went unpublished, a form of outcome-reporting bias that Egger et al., (1997) originally identified in meta-analysis. Recognising these constraints, we treat our synthesis as programmatically generative: it identifies promising mechanisms rather than offering a definitive causal estimate. Future reviews that incorporate francophone, lusophone, and rural African scholarship, as well as grey literature that documents failed cooperative ventures, will be essential to refine, perhaps even contest the collaborative-advantage thesis advanced here.

Managerial Implications

The key theoretical contribution of this study is the melding of RBV with social capital and collective action insights to show that communal relationships and shared assets can be treated as strategic resources yielding lasting advantage, a perspective that de-centers the lone entrepreneur myth and instead puts community at the core of entrepreneurship theory. Practically, our findings encourage reimagining enterprise development from an individual endeavour to a team sport, or as one entrepreneur put it, "The transformation of Africa is not one man's job, it is a job for all of us" (Elumelu, 2021). To ensure these insights translate into



impact, we present tailored recommendations for key stakeholder groups, summarised in a hierarchical matrix of actions (ordered from micro to macro):

(i). For Entrepreneurs & Entrepreneurial Communities: Embrace collaborative training and Ubuntu-based leadership development. We recommend entrepreneurs form or join collective platforms e.g. sector-based cooperatives, shared facilities, or digital peer networks to pool resources and knowledge. Practical steps include drafting group charters that outline shared values and profit-sharing mechanisms, leveraging technology (WhatsApp, blockchain cooperatives) to manage contributions transparently, and rotating leadership roles to build collective management skills. Peer-reviewed tracking of 55 craft cooperatives in Rwanda shows that adopting transparent digital ledgers—a readily implementable step elevated product-quality scores by 18% within a single trading season, confirming the immediate payoff of such governance upgrades (Mogotsi & Baron, 2025). Entrepreneurs should seek out partners and form clusters early, even at ideation stage, to combine competencies for global supply chains. We also suggest incorporating Ubuntu principles in business model canvases, e.g., identify community benefits and communal resource inputs as key parts of the model. Youth entrepreneurship programs can incorporate Ubuntu by organising team-based venture challenges where success is measured by group outcomes. The underlying message for entrepreneurs: collaborate to compete, find strength in numbers and trust, not just in IP and individual talent.

(ii). For Policymakers & AfCFTA Institutions: Design policies that create an enabling ecosystem for collective entrepreneurship. This includes updating cooperative laws to be more flexible (allow hybrid for-profit cooperatives, ease registration and tax benefits for group enterprises) and integrating Ubuntu concepts into national entrepreneurship strategies. The Pan-African Parliament’s 2024 Model Law on Cooperatives has already shortened registration times in pilot countries and offers an immediately actionable legislative template that aligns squarely with our call for cooperative-law reform (Harvey, 2024). At the AfCFTA level, we recommend establishing an “AfCFTA Cooperative Investment Fund” that provides seed capital or matching funds to cross-border joint ventures and consortiums of SMEs. Trade facilitation measures should consider group accreditation enabling a cluster of producers to get one export license or quality certification as a unit. Moreover, government procurement policies can allocate a percentage to cooperatives or require large contractors to include SME groupings in value chains (ensuring collective enterprises have market access). Policymakers must also champion Ubuntu in education, include business ethics and Ubuntu philosophy in curricula to nurture future business leaders who value community.

(iii). For Development Partners, NGOs, and Civil Society: Act as facilitators and capacity-builders of Ubuntu-driven initiatives. Donor programs can fund training in cooperative management, governance, and conflict resolution within group enterprises. NGOs with community ties are well-placed to pilot innovative models (such as platform cooperatives for renewable energy or community-owned agro-processing) that, if proven, governments and markets can scale up. We suggest creating multi-stakeholder forums (involving government, private sector, and community leaders) to share success stories and develop guidelines on Ubuntu-aligned enterprise. Civil society can also serve as watchdogs to ensure that collective ventures remain inclusive (guarding against elite capture) and that policies are implemented in spirit. Looking ahead to 2030, Ubuntu-inspired AI-enabled data commons currently in conceptual pilot represent an aspirational foresight pathway that could democratise training



data access and thus unlock continent-wide machine-learning participation (Sun et al., 2025). Donors should align their aid modalities with Ubuntu: rather than individual grants, support group initiatives, require community co-creation in project design, and measure collective capacity built.

Impact Assessment: Broad adoption of Ubuntu-driven frameworks could be transformative. At the micro level, entrepreneurs would experience less isolation and more support, improving mental well-being and business longevity. At the macro level, Africa's global competitiveness could shift from competing on low labour costs or raw materials to competing on collaborative efficiency, a comparative advantage in working together to create complex products, manage large projects, and swiftly adapt to changes (because communities can reallocate resources more fluidly than disconnected firms). This would contribute to a more inclusive growth model, reducing inequality as gains are shared. It also directly supports sustainable development: collective enterprises inherently consider social and environmental facets, aligning business with community needs (SDG 11, 12, 13).

Conclusions and Future Research

This study set out to advance a transformative understanding of how Ubuntu, far more than a cultural ideal can be leveraged as an engine of African entrepreneurship and competitive strategy. We delivered the first integrative SLR on this topic, revealed strong evidence that Ubuntu-driven resource pooling can foster innovation, increase market competitiveness, and align business practice with sustainability and equity. Our proposed multi-level framework redefines competitive advantage as inherently collaborative in the African context: in a world of AfCFTA-enabled opportunities and global challenges that demand cooperation, “I am because we are” is not just ethical wisdom but a practical strategy. It challenges conventional narratives that often cast African business practices as impediments; instead, it illuminates Ubuntu as a wellspring of collaborative advantage that the world can learn from. The African proverb, “If you want to go far, go together,” rang true in our findings. It is now up to stakeholders across sectors to act on this insight, forging policies, ventures, and networks that embody Ubuntu, thus ensuring Africa not only competes in the global arena but does so on its own terms, championing a model of prosperity that is deeply human and shared by all.

Future Research & Foresight: Building on this seminal study, we propose several avenues for future inquiry and a foresight outlook toward 2035: (1) *Longitudinal Studies of Ubuntu Enterprise Clusters*: Researchers should track communities of entrepreneurs over 5–10 years to observe how Ubuntu-based collaborations evolve, the conditions under which they thrive or falter, and long-term impacts on livelihoods and competitiveness. (2) *Cross-Continental Comparative Research*: A comparative analysis between African Ubuntu-driven networks and similar collectivist ecosystems in Asia or Latin America would enrich global theory and practice, identifying universal vs. culture-specific factors. (3) *Ubuntu in the Digital and AI Economy*: With rapid digitalisation, studies could explore how AI and blockchain technologies might enable “smart” Ubuntu enterprises (for example, autonomous trust networks or decentralised cooperative platforms) and what governance innovations are needed. (4) *Foresight on Trade Blocs*: Scenario planning research examining African competitiveness in 10–15 years under different geopolitical shifts-in each scenario, analyse how Ubuntu-centric strategies might give African businesses resilience. (5) *Ubuntu and Sustainability Transitions*: Investigate how Ubuntu-driven collective action can accelerate progress on climate adaptation and green entrepreneurship (community solar farms, etc.), providing a model for achieving



SDGs through local cooperation. In looking toward 2035, our foresight suggests that if current trends hold with AfCFTA maturing, Africa's youth embracing both tech and communal values, and global supply chains seeking more distributed models, Ubuntu-based entrepreneurship will be a cornerstone of Africa's distinct competitive identity. Africa could very well lead a global movement redefining business success as collective well-being, proving that in unity lies not just strength, but also innovation, prosperity, and sustainability for future generations.



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Exploring the Effectiveness and Implementation Challenges of Performance Management Systems in Rustenburg Mines

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Abstract

The South African mining sector continues to face significant productivity pressures, labour instability, and governance challenges that necessitate strong performance management systems (PMS) to ensure accountability and operational efficiency. In high-risk and performance-driven environments such as Rustenburg mines, effective performance governance is critical for aligning employee output with organisational objectives while promoting fair and transparent workplace practices. This study assessed the effectiveness and implementation dynamics of performance management systems within selected Rustenburg mining operations.

A descriptive research design was adopted, combining structured survey questionnaires and semi-structured interviews. Data were collected from employees across different occupational categories as well as managerial personnel directly involved in administering PMS. Quantitative data were analysed using descriptive statistics, while qualitative interview data were subjected to thematic analysis to identify recurring patterns and perceptions.

The findings revealed that although formal PMS policies are in place, implementation remains inconsistent. Key challenges include limited supervisory training, perceived bias in performance evaluations, weak alignment between appraisal outcomes and reward structures, and insufficient continuous feedback mechanisms. These structural and governance weaknesses reduce the motivational impact and credibility of the system.

The study contributes to performance management literature by providing context-specific evidence from the mining sector and by integrating motivational theory with governance considerations. Furthermore, the findings highlight the relevance of PMS in advancing Sustainable Development Goals, particularly SDG 8 (Decent Work and Economic Growth) and SDG 16 (Strong Institutions), by promoting accountable and transparent workforce management practices.

Keywords: Governance; Mining sector; Performance management systems; Sustainable workforce development; Workplace motivation

1. Introduction

Organisational performance is significantly improved by performance management systems (PMS) in a variety of sectors, such as the mining industry. Organisations can cultivate a culture



of accountability and continuous improvement by establishing defined objectives, monitoring progress, and evaluating employee performance through the implementation of such systems. Literature demonstrates that effective PMS can result in increased employee motivation and job satisfaction, which are essential for the successful attainment of organisational objectives (Madlabana & Petersen, 2020; Mabasa & Flotman, 2022). Additionally, it has been shown that the integration of training and development programs within these systems can improve employee performance, suggesting a synergistic relationship between performance management strategies and employee training (Sbusisiwe *et al.*, 2021; Mabasa *et al.*, 2022).

However, the successful implementation of PMS is supported by effective change management practices that encourage employee buy-in and adaptability (Mabasa *et al.*, 2022). The research emphasises that organisations that have well-structured PMS are more capable of aligning individual performance objectives with overarching organisational objectives, which leads to improved operational efficiency and productivity (Eybers *et al.*, 2019). Performance management's efficacy is contingent upon its contextual implementation and organisational culture, which can differ substantially among industries (Côté-Boileau *et al.*, 2021; Mabasa *et al.*, 2022). In the mining sector, the complexities of the working environment emphasise the necessity of a customised approach to PMS that takes into account both operational challenges and employee engagement strategies.

The South African mining sector is confronted with substantial productivity pressures that are the result of a variety of factors, including the increasing demand for sustainable practices, regulatory constraints, and economic volatility. Organisations are compelled to maintain environmental and safety compliance while simultaneously optimising their operations and improving efficiency by these pressures (Ngcobo *et al.*, 2022; Kurniawan & Gunawan, 2024). A study has shown that the economic challenges encountered by mining companies are frequently exacerbated by high labour costs and operational inefficiencies, which are significant barriers to productivity in the mining industry (Eybers *et al.*, 2019; Lumadi & Nyasha, 2024). Consequently, organisations are increasingly focusing on the implementation of sophisticated technological solutions and process optimisations to alleviate these productivity pressures.

Additionally, the competitive environment demands an unwavering commitment to the implementation of cutting-edge technologies, including automation and data analytics, in order to optimise operations. Nevertheless, the reluctance to adopt such technologies, which is frequently the result of entrenched organisational cultures and resistance to change, is a significant obstacle that can impede productivity improvements (Ngcobo *et al.*, 2022; Edoun, 2023; Lumadi *et al.*, 2024). Mining organisations must prioritise the strategic implementation of performance management systems that not only improve operational efficiency but also correspond with the changing market demands and sustainability initiatives in order to thrive in this dynamic environment (Sbusisiwe *et al.*, 2021; Ngcobo *et al.*, 2022). A comprehensive strategy that incorporates employee development, technology adoption, and organisational culture transformation is required to encourage sustainable success in the mining sector due to the interconnectivity of these productivity pressures and performance management.

The efficiency of performance management systems (PMS) in practice is still being undermined by persistent challenges, despite their widespread adoption across mining organisations. However, the implementation of PMS in numerous Rustenburg mines is inconsistent, administratively driven, and inadequately incorporated into daily managerial



processes. Frequently, supervisors are unable to conduct objective evaluations due to a lack of time, training, and skills, while employees perceive appraisal systems as procedural obligations rather than developmental tools.

Additionally, it appears that there is a lack of alignment between the actual performance of the organization, the reward structures, and the outcomes of the performance appraisals. Employee motivation may decrease when appraisal ratings are not transparently linked to meaningful incentives, career progression, or developmental opportunities, which could potentially impact productivity and morale. This misalignment raises concerns about the strategic value of PMS as a catalyst for workforce engagement and performance development.

These challenges are further complicated by the scarcity of empirical evidence that investigates the operation of performance management systems in the specific context of Rustenburg mines. While existing research provides generalised insights, it fails to account for the contextual realities, workforce perceptions, and operational constraints that are distinctive to this mining environment. As a result, it is necessary to conduct a comprehensive evaluation of the strategic contribution, implementation dynamics, and effectiveness of PMS within Rustenburg mines.

The research objective for this study is to evaluate the effectiveness and implementation of performance management systems in Rustenburg mines and their alignment with organisational goals and performance outcomes, and the research aim is to explore the Effectiveness and Implementation Challenges of Performance Management Systems in Rustenburg Mines.

This study contributes to the field of human resource management and performance management scholarship by offering empirical evidence that is context-specific and derived from the mining sector, an area in which there is a dearth of research. The study furthers academic discourse on strategic HR alignment, appraisal practices, and reward-performance linkages in industrial environments by analysing the efficacy and implementation of performance management systems within Rustenburg mines.

In practical terms, the results provide valuable insights for mining organisations that are interested in improving employee motivation, improving supervisory capability, and strengthening performance governance by implementing more transparent and aligned appraisal systems. The study also has policy relevance by promoting sustainable workforce development through fair, accountable, and performance-driven management practices, thereby improving productivity and long-term organisational sustainability.

The paper is divided into six primary sections. The initial portion presents the study by delineating the backdrop, problem statement, research purpose, and significance of the research. A comprehensive review of pertinent literature, including performance management systems, appraisal methodologies, motivation theories, implementation challenges, and alignment with Sustainable Development Goals, is provided in the second section. The third section describes the research methodology, which encompasses the research design, sampling strategy, data acquisition procedures, and methods of analysis. The research's empirical findings are presented and analysed in the fourth section. The findings are discussed in relation to the extant literature and theoretical frameworks in the fifth section. The sixth section concludes the study, delineates its constraints, and provides suggestions for future research and practice.



2. Literature Review

2.1 Performance Management Systems in Organisations

Performance Management Systems (PMS) are structured frameworks that organisations implement to measure, manage, and optimise employee performance and organisational outcomes. The alignment of individual objectives with broader organisational objectives is essential, as it enables the realisation of strategic objectives. PMS may consist of a variety of elements, such as professional development, continuous feedback, performance appraisal, and goal setting (Chaudhry *et al.*, 2020). The primary objective of PMS is to improve productivity and efficiency by providing employees with frequent assessments and clear expectations, thereby enabling them to achieve their optimal performance. Chaudhry *et al.* (2020) have observed that effective performance management is crucial in the education sector. Still, it also has significant implications for various industries, such as mining and other resource-based organisations.

PMS must address a variety of distinctive challenges in the mining industry, including environmental impacts, operational safety, and regulatory compliance. Therefore, the definitions and concepts of PMS must be modified to accurately reflect the dynamic operational environments of organisations such as those in the Rustenburg mining sector (Pelders *et al.*, 2021). Additionally, the integration of technology in PMS, which includes the adoption of digital tools, has revolutionised traditional methodologies, thereby enabling real-time performance monitoring and data-driven decision-making processes, which are recognised as essential in the contemporary business environment (Fitriadi & Ayob, 2023; Jia *et al.*, 2024).

The implementation of PMS is typically characterised by a cyclical process that includes planning, monitoring, evaluating, and improving performance. Setting clear objectives, defining performance indicators, collecting relevant data, conducting performance evaluations, and engaging in feedback and development initiatives are among the core elements of this cycle, which can vary slightly among organisations (Calvosa, 2020; Baiochi *et al.*, 2021). Particularly in industries such as mining, where operational efficiencies and external conditions can vacillate significantly, the agile adaptation of these processes is essential.

For instance, in mining operations, a successful PMS must incorporate real-time data from production activities to accurately evaluate performance and make timely adjustments. Pelders *et al.* (2021) assert that optimising shift patterns and integrating worker feedback into performance assessments can substantially influence productivity and safety in mining operations (Pelders *et al.*, 2021). Furthermore, the implementation of advanced methodologies, including Value Stream Mapping (VSM), can pinpoint inefficiencies in coal production processes, thereby resulting in improved operational performance (Indriati *et al.*, 2023). In project management systems (PMS), strategic alignment is the process of guaranteeing that the performance objectives of individuals and teams are in accordance with the organization's overarching strategic objectives. Effective strategic alignment can improve the overall performance and achievement of objectives by improving the coherence of actions taken by employees (Baiochi *et al.*, 2021). A thorough comprehension of regulatory standards, market conditions, and stakeholder expectations is necessary in the mining sector.



A culture of open communication and collaboration among employees and management must be encouraged by PMS to achieve this alignment. Organisations that effectively align their performance management initiatives with their strategic direction exhibit improved operational efficiencies, improved resource management, and higher levels of engagement from their workforce, as emphasised by industrial performance studies (Baiochi *et al.*, 2021). As businesses endeavour to satisfy environmental, social, and governance (ESG) standards, the integration of sustainability metrics into performance evaluations has grown in importance (Carneiro & Fourie, 2019; Jia *et al.*, 2024). To ensure sustainable performance management in the Rustenburg mining context, it will be essential to resolve economic pressures while maintaining alignment with social and environmental objectives.

2.2 Challenges in Performance Management Systems

The effectiveness of Performance Management Systems (PMS) is hindered by a variety of challenges, despite their critical role as frameworks within organisations to improve employee performance. The primary obstacles consist of feedback limitations, concerns regarding trust and fairness, supervisory competency, and appraisal distortions such as central tendency, leniency, and halo. These issues are particularly relevant in the context of performance assessments in the mining sector in Rustenburg, South Africa, where organisational dynamics can be intricate and distinctive. Performance management systems are perpetually confronted with appraisal distortions, including central tendency, leniency bias, and the halo effect. When a supervisor permits a single positive attribute of an employee to influence their overall evaluation, the halo effect may result in the results being unduly distorted (Nkgapele, 2024). Leniency bias is the inclination of evaluators to rate employees more favourably than is justified, thereby restricting the differentiation between various levels of performance (Casoojee, 2024). Central tendency bias is demonstrated when appraisers refrain from assigning extreme ratings and instead organise their evaluations around the midpoint of the scale. This can obscure genuine performance deficiencies and fail to accurately represent the capabilities of employees (Langton & Mafini, 2023). These distortions, when combined, can result in unreliable performance evaluations and can demotivate high performers, while simultaneously failing to adequately address the development requirements of lower performers.

Another significant obstacle within performance management systems is the limitations of feedback. Employee development necessitates effective feedback; nevertheless, its efficacy is frequently compromised by its absence of specificity, frequency, and clarity (Grammatico *et al.*, 2025). Ncube (2023) notes that in South Africa, organisational contexts frequently demonstrate an inadequate commitment to providing constructive and timely feedback, which is essential for promoting employee development and improved performance outcomes. The purpose of performance management systems can be undermined by this inadequacy in communication, which can result in confusion and dissatisfaction among employees. The employee-supervisor relationship can be further complicated by the absence of structured mechanisms for continuous feedback, which can prevent employees from understanding their performance goals or the steps necessary to attain them (Prummer *et al.*, 2023).

The successful implementation of performance management systems is significantly prevented by trust and impartiality concerns. Employees' perceptions of bias, inequity, or lack of transparency in performance evaluations can cause a decline in morale and engagement by undermining trust in the process (Khoza-Shangase & Masondo, 2020). Employees may



experience defensiveness, diminished initiative, and even disengagement from their positions when they perceive that their evaluations are not conducted impartially (Dunjana *et al.*, 2022). This is especially relevant in the mining operations of Rustenburg, where socio-economic factors may exacerbate sentiments of injustice or discrimination in performance assessments. For performance management systems to function efficiently, organisations must establish a culture of accountability and impartiality, guaranteeing that performance metrics are impartial and transparent (Netshakhuma, 2021).

The execution and efficacy of performance management systems are contingent upon supervisory competence. The knowledge, skills, and dispositions of the supervisors who are responsible for evaluating employee performance have a substantial impact on the effectiveness of a PMS. Supervisors may not possess the necessary training to effectively deliver constructive feedback and conduct fair and objective evaluations (Madikizela *et al.*, 2022). This deficiency may result in the inconsistent application of performance standards, which can further exacerbate employee dissatisfaction and demotivation. Ramavhoya *et al.* (2021) emphasise the importance of effective training programs that are specifically designed to improve supervisory skills in performance evaluation and employee development to achieve improved results within PMS frameworks. This is especially important in industries like mining, where leadership is essential for addressing the unique performance management challenges this sector presents.

2.3 Motivation, Rewards, and Performance Management

Motivation, which is distinguished by intrinsic and extrinsic factors, is a critical component of performance management systems (PMS). Intrinsic motivation is derived from a sense of accomplishment and personal satisfaction. The engagement of employees with their work, values, and self-determination is directly correlated (Berdicchia *et al.*, 2021; Kumari *et al.*, 2021). In contrast, extrinsic motivation is propelled by external incentives, like bonuses, promotions, and recognition (Dagher *et al.*, 2024; Nkoana & Matjie, 2024). The cultivation of a comprehensive organisational culture that motivates employees to elevate their performance necessitates the integration of both motivational types. Despite the fact that extrinsic rewards can effectively stimulate short-term performance improvements, research underscores the importance of intrinsic motivation for long-term job satisfaction and sustained engagement (Saisudha, 2025; Samrat *et al.*, 2025). Aligning both intrinsic and extrinsic motivators is essential for maintaining workforce morale and productivity, particularly in the mining sector, where the environment can be challenging (Okocha *et al.*, 2022).

Employees are motivated to perform according to expectancy theory, which posits that the anticipated outcome of their endeavours is influenced by three critical components: expectancy, instrumentality, and valence (Berdicchia *et al.*, 2021b). The belief that effort will result in performance is referred to as expectancy, while instrumentality is the belief that performance will lead to desired outcomes. Valence is the value that is placed on those outcomes. Clear communication of reward structures can improve employees' perceptions of instrumentality, thereby reinforcing their motivation to perform at high levels, which is particularly important in mining operations, where safety and efficiency are of the utmost importance (Kumari *et al.*, 2021; Saputri & Hidayat, 2021). Expectancy theory can be effectively implemented in performance management to improve productivity, as employees are more inclined to invest in their duties when they perceive a fair correlation between effort and reward (Sikuku *et al.*, 2021; Vassilev *et al.*, 2024).



The significance of fairness in performance management systems and the impact of perceived injustices on employee motivation are highlighted by equity theory (Vassilev *et al.*, 2024; Saisudha, 2025). Employees compare their input-output ratios with those of their colleagues in order to ensure that they are recognised and rewarded fairly for their contributions. Equity perceptions are especially critical in the mining industry, as discrepancies in reward allocation can result in worker dissatisfaction and decreased productivity (Berdicchia *et al.*, 2021a). Research has shown that organisations that implement equitable reward systems encourage trust and motivation among their employees, which in turn leads to improved performance and decreased turnover rates (Noorazem *et al.*, 2021; Samrat *et al.*, 2025). Addressing equity in a comprehensive manner is particularly important when employees are involved in physically demanding work, as fatigue may impact their performance levels.

Aligning rewards with performance outcomes reinforces desired behaviours and results within organisations. Performance management systems that are effective not only assess outputs but also ensure that rewards are customised to reinforce specific objectives, thereby motivating employees to strive for excellence (Mpando & Chipindi, 2024; Vassilev *et al.*, 2024). This alignment could entail the establishment of unambiguous performance indicators that are directly correlated with the rewards offered, which include both financial and non-financial incentives, in the context of Rustenburg mines (Manoj & Sabu, 2020; Okocha *et al.*, 2022). Implementing models that incorporate both intrinsic rewards (such as recognition events) and monetary rewards (such as bonuses for achieving safety objectives) can improve the overall satisfaction and motivation of employees (Usman & Harmen, 2021; Boadi *et al.*, 2025). This holistic approach has the potential to cultivate a culture of accountability and high performance among mining employees, resulting in a safer working environment and improved operational efficiency.

2.4 Performance Management Systems and Sustainable Development Goals (SDGs)

Performance Management Systems (PMS) are essential for the promotion of economic growth and respectable work, particularly in sectors such as mining that encounter distinctive obstacles. Labour productivity is improved by the implementation of effective PMS, which facilitates equitable evaluation and performance accountability. The systematic alignment of PMS with corporate culture can cultivate an environment that prioritises transparency and employee engagement, resulting in improved job satisfaction and retention (Kusnadi *et al.*, 2024). Additionally, the identification of skills deficiencies and the determination of training requirements can be facilitated by mechanisms that enable consistent evaluation and feedback, thereby promoting sustainable employment practices and career development (Wang & Ze-tao, 2024). Adopting transparent and equitable evaluation systems can specifically address aspects of workplace culture that affect productivity and labour relations in the context of Rustenburg mines. Mining companies can improve their responsiveness to employee requirements and align their operations with both national and global sustainability frameworks by utilising PMS to implement sustainable workforce management strategies (Vives-Gabriel & Merwe, 2023; Kusnadi *et al.*, 2024).

PMS functions as an essential governance mechanism that improve operational efficacy in a variety of industries, such as mining. The incorporation of efficient PMS into mining operations not only improves industrial performance but also encourages innovation in resource management and extraction processes. A multilevel approach that utilises a variety of performance indicators can assist in the identification of inefficiencies and the development of



innovative solutions (Abdelaal, 2023; Wang, 2023). Additionally, the broader agenda of SDG 9 is inextricably linked to the empowerment of employees through innovative practices and skill development. Companies in Rustenburg mines can sustain their competitive advantages and demonstrate their commitment to sustainable development by consistently adjusting their PMS to evolving industry standards and technological advancements (Abdelaal, 2023; Suresh *et al.*, 2025).

The effective implementation of PMS can have a direct impact on institutional transparency and workplace relations, which are significant themes under SDG 16. Fair appraisal practices encourage an environment of justice in which all employees feel valued and comprehended, thereby reducing workplace conflict. This is especially pertinent in industries that have a history of labour unrest, such as the mining communities in Rustenburg that were affected by the Marikana massacre (Vives-Gabriel *et al.*, 2023). PMS is therefore pivotal in the advancement of ethical governance and accountability in mining operations. Establishing transparent and process-driven appraisal systems is essential for the preservation of trust between management and employees, which is essential for the preservation of a stable and harmonious work environment (Chen *et al.*, 2021; Vives-Gabriel *et al.*, 2023).

Strategically aligned PMS that facilitates sustainable personnel management can be advantageous to the mining sector in Rustenburg. Given the sector's intricacies, which encompass environmental impacts and social challenges, PMS should be developed to guarantee adherence to both local and global sustainability frameworks. For example, the systematic assessment of environmental impacts in conjunction with productivity and safety measures can be facilitated by the integration of data-driven approaches, such as those proposed in recent works on performance evaluation methods (Chen *et al.*, 2021; Berti *et al.*, 2025). Additionally, PMS can aid in the promotion of organisational change that is conducive to the long-term sustainability of mining operations. To guarantee that mining operations are sustainable and equitable, the implications for workforce development, safety, and environmental protection must remain a constant focus of PMS design and implementation (Chiromo & Nani, 2019; Wang *et al.*, 2024).

2.5 Theoretical Framework: Expectancy Theory

A valuable framework for comprehending employee motivation within performance management systems is provided by Expectancy Theory, which was developed by Vroom *et al.* (2015). The theory posits that individuals are incentivised to exert effort when they are convinced that their efforts will result in improved performance (expectancy), desired rewards (instrumentality), and that these rewards are valued (valence). As a result, motivation depends on these three interconnected factors. The alignment between employee performance, reward structures, and performance appraisal outcomes in Rustenburg mines is particularly pertinent in the context of this study, as it examines Expectancy Theory.

The motivation of employees to perform may decrease if they believe that their increased effort will not be fairly evaluated or that the results of their appraisals are not meaningfully linked to rewards such as promotion, recognition, or financial incentives. Similarly, the performance management system's motivational effect is diminished if rewards are not perceived as equitable or valued. Consequently, the efficacy of performance management systems is contingent upon the perceptions of fairness, transparency, and reward alignment held by employees, in addition to administrative procedures. Expectancy Theory, therefore, offers a



theoretical framework through which this investigation assesses the efficacy of performance management practices in Rustenburg mines in motivating employees and improving organisational performance.

2.6 Research Gap

Despite the extensive research on performance management systems (PMS) in the general human resource management literature, there is a significant void in sector-specific research that concentrates on the mining industry. The empirical attention that has been paid to heavy industrial contexts, such as mining, is limited, and the majority of the existing scholarship examines PMS within corporate, service, or public sector environments. The mining sector exhibits distinctive operational characteristics, such as unionised labour structures, productivity pressures, skills shortages, and hazardous working conditions, which may affect the implementation and perception of performance management systems. As a result, the efficacy and practical functionality of PMS within Rustenburg mines are not adequately evaluated by context-specific evidence. Additionally, the literature on performance management in the mining sector has yet to fully incorporate the perspectives of the Sustainable Development Goals (SDGs), particularly SDG 8 (Decent Work and Economic Growth) and SDG 16 (Strong Institutions), despite the growing connection between global discourse and organisational practices. The extent to which PMS contributes to sustainable workforce development, fair evaluation practices, and institutional accountability in industrial contexts is rarely investigated in existing research.

3. Research Methodology

3.1 Research Philosophy and Approach

This study is based on a positivist research philosophy, which posits that structured instruments can be used to objectively measure and analyse organisational phenomena. The positivist perspective is appropriate for the study, which aims to assess the efficacy and implementation of performance management systems by utilising empirical evidence, measurable perceptions, and observable patterns. The development of the research instrument and the formulation of the research questions were guided by a deductive research approach, which drew on established theories such as Expectancy Theory and Equity Theory. The study subsequently transitions from theory to empirical investigation, evaluating the validity of extant theoretical assumptions regarding performance, motivation, and reward alignment in the context of Rustenburg mines. The research endeavours to produce dependable and systematic data that can be analysed to derive objective conclusions regarding the strategic alignment and operation of performance management systems in the mining sector by incorporating a structured survey design and interviews.

3.2 Research Design

A descriptive research design was implemented in this study to assess the efficacy and effective implementation of performance management systems in Rustenburg mines. The study, which aims to systematically describe extant performance management practices, employee perceptions, and implementation challenges without manipulating any variables, was deemed appropriate for a descriptive design. The research is cross-sectional in nature, as data were only collected at a specific point in time from employees and managers within the selected mining operations.



Through structured questionnaires, the design enabled the acquisition of quantitative data to identify patterns, trends, and relationships associated with employee motivation, reward alignment, and performance appraisal processes. Furthermore, qualitative insights were acquired through semi-structured interviews to improve comprehension of implementation dynamics and provide contextual depth. These methods were combined to improve the study's strength by providing interpretive insight and statistical analysis of the operation of performance management systems in the mining environment.

3.3 Study Context

The study was conducted in the Rustenburg region of the North West Province, South Africa, within specific mining operations. Platinum and other mineral extraction activities are notably well-known in Rustenburg, which is one of the country's major mining hubs. The mining sector in this region is characterised by productivity pressures, labour relations challenges, and skills constraints, despite its significant contribution to economic development and employment generation. Performance management systems are crucial mechanisms for alignment of individual contributions with organisational objectives, improvement of accountability, and monitoring employee performance within this context. Nevertheless, the implementation and perception of such systems by employees and management may be influenced by the operational complexity, safety hazards, and hierarchical structures that are typical of mining environments. Therefore, the Rustenburg mining context offers a practical and pertinent environment for the evaluation of the strategic alignment, implementation challenges, and efficacy of performance management systems in an industrial and high-pressure setting.

3.4 Sampling Strategy

The quantitative component was sampled using a probability-based strategy, while the qualitative component was sampled using a non-probability approach. Stratified random sampling was implemented to guarantee equal representation among various employee categories, including supervisors, artisans, and general labourers, for the survey. The sample's representativeness was improved by this method, which captured perspectives from a variety of organisational levels within the mining operations. Participants who were directly involved in the administration and supervision of performance management systems, such as HR managers and line supervisors, were selected through purposive sampling for the qualitative interviews. The selection of these individuals was contingent upon their expertise and practical experience with performance appraisal processes. The study was fortified by the integration of stratified and purposive sampling, which guaranteed both comprehensive representation and informed insight into the dynamics of performance management system implementation within Rustenburg mines.

3.5 Data Collection

Data were gathered through semi-structured interviews and a structured questionnaire. The primary data collection instrument for the quantitative component was a self-administered questionnaire that was intended to collect information on the perceptions of performance management systems, implementation practices, feedback mechanisms, and reward alignment of employees. Likert-scale responses were employed to ensure consistency and facilitate statistical analysis in the questionnaire, which primarily consisted of closed-ended enquiries.



Semi-structured interviews were conducted with supervisors and human resource personnel who were responsible for administering performance management systems to supplement the survey data. The interviews enabled a more thorough examination of policy alignment issues, supervisory practices, and implementation challenges. The questionnaire was pilot-tested to guarantee reliability, relevance, and clarity before it was fully administered. Throughout the data collection procedure, respondents were guaranteed anonymity and confidentiality, and participation was voluntary.

3.6 Data Analysis

Descriptive statistical methods were implemented to analyse the structured questionnaire data. Responses were coded and entered into a statistical software application to produce mean scores, percentages, and frequencies. This allowed for the identification of patterns and trends associated with employee perceptions, reward alignment, and performance management practices. Descriptive analysis was suitable for the study, as its objective was to assess and describe existing conditions rather than to investigate intricate causal relationships.

Thematic analysis was employed to analyse data from semi-structured interviews for the qualitative component. Transcription and systematic review of interview responses were conducted to identify recurring themes and patterns with respect to supervisory capability, implementation challenges, impartiality perceptions, and motivational factors. The integration of quantitative and qualitative findings strengthened the overall analysis by providing both statistical evidence and contextual depth, thereby augmenting the credibility and comprehensiveness of the study's conclusions.

3.7 Trustworthiness of the Study

The study's credibility and reliability were guaranteed through the implementation of numerous measures to improve its trustworthiness. The quantitative component was supported by the use of a structured questionnaire with clearly defined items that were aligned with the research objectives and theoretical framework. Thus, reliability was ensured. The instrument underwent pilot testing to improve its internal reliability and content validity by improving clarity and consistency.

The qualitative component's credibility was improved by employing semi-structured interviews, which enabled participants to provide contextual and detailed responses. Dependability was ensured through the preservation of a transparent audit trail of the data collection and analysis processes. Transferability was addressed by providing a comprehensive description of the study context, which allowed readers to ascertain the relevance of the findings to comparable mining environments. Confirmability was achieved by minimising researcher bias and grounding interpretations in the collected data through systematic coding and analysis procedures.

3.8 Ethical Considerations

The integrity of the study and the protection of participants were guaranteed by the strict adherence to ethical principles throughout the research process. Informed consent was obtained from all respondents before data collection, and participation in the research was



purely voluntary. The purpose of the study, the nature of their involvement, and their right to withdraw at any stage without penalty were all clearly communicated to the participants.

Interview responses were reported without reference to individual names or specific job identifiers, and confidentiality and anonymity were preserved by assuring that no identifying information was included in the questionnaires. The data that was collected was exclusively used for academic purposes and was securely stored to prevent unauthorised access. The study was conducted in a manner that maintained ethical standards that are pertinent to research conducted in organisational settings, thereby avoiding injury, coercion, or undue influence.

4. Findings

4.1 Participant Profile

Participant	Role / Position	Area of Expertise	Sector Exposure	Years of Experience
P1	HR Manager	Performance Management & HR Policy	Mining	12 years
P2	HR Manager	Talent Management & Appraisals	Mining	10 years
P3	HR Manager	Labour Relations & PMS Administration	Mining	15 years
P4	HR Manager	HR Operations & Performance Systems	Mining	9 years
P5	Engineer	Production Oversight & Performance Monitoring	Mining	14 years
P6	Engineer	Technical Supervision & Output Control	Mining	11 years
P7	Engineer	Engineering Performance Standards	Mining	13 years
P8	Engineer	Operational Efficiency Management	Mining	8 years
P9	Artisan	Technical Maintenance & Task Execution	Mining	7 years
P10	Artisan	Equipment Maintenance & Output Targets	Mining	9 years
P11	Artisan	Mechanical Operations	Mining	6 years
P12	Artisan	Underground Technical Services	Mining	10 years
P13	Artisan	Plant Operations	Mining	5 years
P14	Artisan	Maintenance & Compliance	Mining	12 years
P15	Artisan	Electrical Maintenance	Mining	8 years
P16	Artisan	Production Support Services	Mining	11 years
P17	Artisan	Field Operations	Mining	6 years



P18	Artisan	Equipment Monitoring	Performance	Mining	9 years

4.2 Emergent Themes

The following section defines the primary themes that were identified through the analysis of data collected from employees and administrators within specific Rustenburg mines. The themes represent collective perceptions and experiences concerning the fairness, efficacy, and implementation of performance management systems in the mining sector. The results specifically emphasise the structural and operational challenges associated with the implementation of PMS, the overall motivational impact of the system on employee performance and organisational outcomes, and concerns regarding perceived bias and reward alignment. These themes collectively offer a perspective on the practical experience of performance management practices and the degree to which they contribute to the sustainable development of the workforce, accountability, and performance improvement in the mining sector.

Theme 1: Implementation and Structural Effectiveness of Performance Management Systems

- *“The performance management policy is clearly documented, but its implementation varies significantly depending on the supervisor.” (P1)*
- *“Although reviews are scheduled annually, there is limited structured follow-up throughout the year.” (P5)*
- *“Some managers treat the appraisal process as a compliance exercise rather than a developmental tool.” (P6)*
- *“Supervisors are expected to apply objective standards, yet not all have received formal training in performance evaluation.” (P2)*
- *“The system appears strong on paper, but practical execution is inconsistent across departments.” (P3)*
- *“Operational demands in the mining environment often result in performance discussions being rushed.” (P7)*
- *“There is a lack of standardisation in how performance ratings are applied across different sections.” (P4)*
- *“Employees are not always clear on how their performance targets link to overall production goals.” (P8)*
- *“Documentation is completed as required, but meaningful engagement during reviews is sometimes limited.” (P9)*
- *“The timing of reviews is not always aligned with operational cycles, which affects relevance.” (P10)*
- *“In some cases, performance objectives are not clearly defined at the beginning of the evaluation period.” (P11)*



- *“Monitoring mechanisms exist, but they are not consistently enforced across all levels.” (P12)*
- *“The effectiveness of the system largely depends on individual managerial commitment rather than institutional enforcement.” (P14)*

The implementation of performance management systems within Rustenburg mines was consistently perceived by participants as structurally present but operationally contradictory. Although formal PMS policies and appraisal frameworks are documented and institutionalised, their execution varies substantially across departments and supervisory levels, as evidenced by multiple participants. However, the results indicate that performance management is frequently perceived as an administrative obligation rather than a continuous developmental process. Participants also emphasised that the practical effectiveness of the system is compromised by inconsistencies in supervisory training, limited mid-cycle feedback, and operational production pressures. These structural vulnerabilities seem to be the result of insufficient managerial capability and inadequate monitoring mechanisms, rather than deliberate neglect. Several participants observed that the system's relevance to daily operational realities is diminished by the absence of continuous performance engagement. These perceptions emphasise a discrepancy between the formal PMS structures and the actual practice. The results suggest that the mines' intended contribution to accountability, alignment, and organisational performance outcomes is significantly compromised by inconsistent implementation and limited institutional enforcement, despite the fact that they possess established performance management frameworks.

Theme 2: Perceived Fairness, Bias, and Reward Alignment

- *“Performance ratings sometimes appear influenced by personal relationships rather than objective criteria.” (P9)*
- *“Employees often question whether the appraisal process is applied consistently across departments.” (P10)*
- *“There is a perception that high ratings do not always translate into meaningful financial rewards.” (P7)*
- *“Some employees feel that the system lacks transparency in how final scores are determined.” (P12)*
- *“Even when targets are achieved, bonuses are not always aligned with the performance results.” (P5)*
- *“Bias can occur when supervisors favour certain team members based on familiarity.” (P11)*
- *“Promotion decisions do not always seem directly linked to documented performance outcomes.” (P14)*
- *“Employees are uncertain about how their ratings impact salary progression.” (P13)*
- *“The absence of clear communication around reward allocation creates mistrust.” (P3)*



- *“There is a perception that the rating scale is interpreted differently by different managers.” (P6)*
- *“Some employees believe the evaluation process lacks procedural fairness.” (P15)*
- *“Where reward structures are unclear, motivation to perform at higher levels declines.” (P8)*
- *“Transparency in linking performance results to incentives remains a significant concern.” (P4)*

The perceived impartiality and transparency of performance appraisal processes within Rustenburg mines were consistently the subject of participants' concerns. The practical application of rating systems is frequently perceived as subjective and influenced by interpersonal dynamics, despite the existence of formal evaluation criteria, as many participants indicated. These perceptions indicate that procedural impartiality is undermined by the absence of standardised interpretation of rating scales and inconsistencies in supervisory judgement. Additionally, participants identified a substantial disparity between reward structures and performance outcomes. High performance ratings do not consistently result in financial incentives, career advancement, or formal recognition, as indicated by numerous respondents. This system's motivational potential is diminished by its feeble instrumentality, which undermines confidence in its credibility. Employees debated whether appraisal results have a substantial impact on remuneration adjustments or promotion decisions in certain cases. These results collectively suggest that the legitimacy of the performance management system is significantly undermined by perceived bias and deficient reward alignment. Employee engagement and organisational commitment may be compromised in the mining environment due to the absence of transparent communication and clearly defined reward linkages, which could potentially diminish trust.

Theme 3: Motivational Impact and Organisational Performance Outcomes

- *“When performance feedback is constructive and specific, it encourages employees to improve their output.” (P8)*
- *“If employees believe the system is fair, they are more committed to meeting production targets.” (P4)*
- *“Clear performance expectations help align individual effort with organisational goals.” (P1)*
- *“Where performance results are acknowledged, morale within teams improves.” (P14)*
- *“Employees become disengaged when they feel that performance ratings do not lead to tangible outcomes.” (P11)*
- *“A well-implemented performance management system strengthens accountability across departments.” (P6)*
- *“Motivation increases when supervisors recognise performance achievements beyond formal appraisals.” (P2)*
- *“Inconsistent performance evaluations reduce trust and negatively affect productivity.” (P9)*



- *“When goals are clearly communicated at the beginning of the cycle, employees perform with greater focus.” (P5)*
- *“Linking performance outcomes to career progression would significantly improve employee motivation.” (P7)*
- *“The system has the potential to improve organisational performance, but only if it is implemented consistently and fairly.” (P3)*

Participants generally recognised that performance management systems have the potential to positively impact organisational performance and employee motivation when implemented effectively. Several respondents suggested that the improvement of focus, accountability, and productivity is facilitated by the provision of constructive feedback, recognition of achievement, and explicit goal setting. Employees are purportedly more dedicated to accomplishing operational objectives when performance expectations are explicitly communicated and consistent with production targets.

At the same time, participants emphasised that the system’s motivational influence is contingent upon the perceived impartiality and reward alignment. Employees reported diminished engagement and enthusiasm in situations where appraisal outcomes are not meaningfully associated with incentives or career advancement. The results indicate that the system’s efficacy as a performance-improving mechanism is compromised when effort is not visibly linked to tangible outcomes, as motivation decreases.

The findings suggest that the performance management system has the structural capacity to improve organisational performance; however, its actual influence on productivity and motivation is contingent upon consistent implementation, transparent evaluation processes, and credible reward linkages within the mining context.

5. Discussion

The results of this study indicate that there are distinct correlations between the efficacy of performance management systems and specific Sustainable Development Goals (SDGs), including SDG 8 (Decent Work and Economic Growth) and SDG 16 (Peace, Justice and Strong Institutions). To begin, the direct contribution of effective and consistently implemented performance management systems to SDG 8 is the promotion of productive employment, accountability, and performance-driven organisational growth. Participants reported that employee motivation and productivity are improved when performance expectations are explicitly defined, feedback is constructive, and rewards are tailored to the desired outcomes. These practices are crucial for the sustainable development of the mining workforce in the industry, as they promote equity, performance transparency, and merit-based recognition, all of which are essential for the establishment of decent work conditions. Institutional integrity and transparency are compromised by governance vulnerabilities identified in the findings, including perceived bias, inconsistent implementation, and weak reward alignment, thereby challenging SDG 16. Trust in organisational systems is diminished when performance evaluations lack procedural impartiality or credible accountability mechanisms. The findings indicate that it is imperative to improve performance governance structures within mining operations to promote sustainable and ethical industrial development, in addition to improving organisational efficacy.



5.1 Alignment of Performance Management Findings with Sustainable Development Goals (SDGs)

Performance Management Systems (PMS) are essential for the advancement of Sustainable Development Goal (SDG) 8, which aims to encourage sustainable, inclusive, and productive economic growth, complete and productive employment, and decent work for all. Establishing distinct metrics for productivity, safety, and sustainability can improve organisational performance in the mining sector through the implementation of effective PMS. Research suggests that the mining industry can contribute to SDG 8 by assuring decent work through rigorous performance auditing methods that are designed to improve working conditions and promote engagement among employees (Sari *et al.*, 2022; Silva & Anna Luiza Marques Ayres da, 2024). Additionally, effective PMS can promote transparency and accountability, which are essential for cultivating an environment that is conducive to the attainment of full employment and economic development in the mining sector (Ivic *et al.*, 2021; Fuentes *et al.*, 2024).

Additionally, it has been suggested that the operational sustainability of minerals extraction can be significantly improved by the implementation of strong governance frameworks in conjunction with PMS. This aligns actions with the objectives of SDG 8, particularly those related to economic growth and employment creation (Chu *et al.*, 2021; Keita *et al.*, 2022). For example, mining organisations that implement comprehensive PMS are considerably less susceptible to operational inefficiencies that could potentially impede their contributions to economic development and job creation (Palmer *et al.*, 2020; Ivic *et al.*, 2021). Concurrently, the incorporation of environmental, social, and governance (ESG) criteria into PMS can guarantee that the employment produced by the mining sector is consistent with the protection of labour rights and fosters secure and safe work environments (Ivic *et al.*, 2021; Cranford, 2023).

The integrity of governance frameworks in the mining sector is essential for the achievement of Sustainable Development Goal 16, which is to encourage peaceful and inclusive societies for sustainable development, ensure access to justice for all, and establish effective, accountable, and inclusive institutions at all levels. These objectives can be profoundly undermined by weak governance, which can exacerbate issues such as corruption, lack of transparency, and inadequate stakeholder engagement (Chu *et al.*, 2021; Ikhsan *et al.*, 2025). Unregulated practices that not only compromise social and environmental standards but also undermine local community trust in mining operations can result from governance weaknesses in the context of mining operations (Brisbois *et al.*, 2021; Gutiérrez-Díez *et al.*, 2024).

Scholarly analyses have identified that the absence of robust governance structures in developing nations frequently results in a disconnect between policy frameworks and the realities on the ground, particularly in areas where mining activities exacerbate social inequities and environmental hazards (Silva *et al.*, 2023; Umore *et al.*, 2025). For example, the mining industry is frequently involved in disputes regarding land rights and community welfare, emphasising the importance of local governance in mediating between corporate interests and community needs (Essah, 2021). Consequently, it is essential to strengthen governance mechanisms, particularly those that prioritise stakeholder engagement and accountability, in order to achieve SDG 16, as this not only promotes public trust but also improves regulatory compliance and sustainable practices within the mining industry (Danso *et al.*, 2022; Ikhsan *et al.*, 2025; Umore *et al.*, 2025).



The implications of effective performance management and governance in mining are not limited to immediate operational efficiencies; they also extend to broader sustainability outcomes. The operations of the mining sector have a substantial impact on local and global environmental and social systems, and it is intrinsically linked to a variety of Sustainable Development Goals. A mechanism that can be used to mitigate environmental impacts, support community engagement, and improve economic benefits is an effective PMS that is supported by strong governance (Cranford, 2023; Fuentes *et al.*, 2024).

Mining companies are encouraged to adopt responsible resource extraction practices and adopt social responsibility through the implementation of effective management frameworks that evaluate key performance indicators in accordance with the Sustainable Development Goals (Keita *et al.*, 2022; Silva *et al.*, 2024). Furthermore, the operational efficiencies of mining operations can be improved, and mining practices can be made more responsive to sustainability benchmarks through the integration of technology, such as artificial intelligence and data analytics (Cranford, 2023; Silva *et al.*, 2023). To cultivate broader implications of sustainable mining performance, it will be imperative to establish a strong connection between the Sustainable Development Goals, PMS effectiveness, and governance frameworks as mining companies continue to navigate the responsibility of environmental stewardship and social equity.

6. Conclusion

Selected Rustenburg mines were assessed for their performance management systems (PMS) implementation and efficacy in this investigation. Although formal PMS frameworks are established and supported by documented policies, their practical application remains inconsistent, the findings revealed. The system's efficacy is diminished by operational pressures, limited continuous feedback, and variations in supervisory capability. Employee trust and motivational impact are further diminished by concerns regarding perceived bias and insufficient alignment between appraisal outcomes and reward structures. Although participants acknowledged the potential of PMS to improve accountability and performance alignment, its impact on organisational performance is contingent upon credible incentive linkages, consistent governance, and transparency. The study contributes to the performance management literature by offering context-specific evidence from the South African mining sector, which has a scarcity of empirical research. In a high-risk industrial environment, it emphasises the interaction between structural implementation, fairness perceptions, and motivational outcomes, thereby expanding existing scholarship. Furthermore, the study contributes to the governance of a sustainable workforce by illustrating the potential of transparent and equitable PMS practices to encourage accountability, decent work conditions, and performance-driven development that are consistent with the overarching sustainability principles.

The research was geographically restricted to certain Rustenburg mines, hence constraining the applicability of the findings to other mining areas or industries. The dependence on self-reported perceptions via questionnaires and interviews may result in response bias. Moreover, the cross-sectional research methodology collected data at a singular moment and did not evaluate long-term performance patterns or causal connections between PMS effectiveness and productivity outcomes.



Through transparent performance-reward alignment, consistent monitoring mechanisms, and structured supervisory training, mining organisations should improve the implementation of PMS. Improving accountability and workforce engagement can be achieved by positioning PMS as a strategic driver of sustainable employment. HR systems should also be in accordance with the Sustainable Development Goals and national development priorities to help strengthen ethical governance. Future research should consider quantitative productivity measures, sector comparisons, and longitudinal studies to improve comprehension of sustainable performance governance in industrial contexts.



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KOMB Green Solutions: A Case Study of Youth-Led Sustainability and Urban Renewal in Korogocho Slums

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Abstract

This case study critically examines KOMB Green Solutions, a youth-led sustainability initiative located in Korogocho—a densely populated informal settlement in Nairobi, Kenya. Urban settlements like Korogocho often see problems exacerbated by the underlying socioeconomic precarity. The prevalence of socioeconomic stagnation and crime in Kenya and many African nations is widely acknowledged to be compounded by issues of systemic corruption and inequality, which diminish development prospects for millions and exclude the poor majority. Situated against this challenging socioeconomic backdrop, KOMB Green Solutions, a grassroots and community-based organisation, represents a compelling local response. Remarkably, by this organisation engaging previously marginalized young people, including reformed offenders, the initiative directly deals with the intertwined challenges of ecological decline and urban marginalisation, underlying the potential for communication-based action to foster transformation. The core work of this non-governmental organisation—restoring degraded riverbanks, converting waste into fuel, and developing tree nurseries—shows a pragmatic strategy for sustainable development agendas. Adopting a bottom-up, community-based approach to addressing chronic ecological challenges is the most feasible way to tackle the long-term problems. The example of KOMB Green Solutions demonstrates how young people can conserve the environment and also attain multiple UN Sustainable Development Goals (SDGs). In the end, the future of the planet is in the hands of young people who are likely to be affected if they are left on the periphery and are not involved or do not take an active role in protecting the natural surroundings.

Keywords: bottom-up, conservation, crime, governance, sustainability, youth

1. Introduction

1.1 Background

The need to involve young people in environmental conservation and the attainment of Sustainable Development Goals (SDGs) cannot be overstated. According to Oyeniyi et al. (2024), the vibrancy, creativity, innovative behaviour, and dynamism of African youth have the potential to spark remarkable changes across various sectors. Indeed, the United Nations (UN) has reaffirmed this by stating that empowered young people are vital for a peaceful and sustainable future (Oyeniyi et al., 2024). Unfortunately, researchers have painted a grim picture of how governments, especially in sub-Saharan Africa, continue to leave the youth behind in sustainability efforts (Chirambo, 2018; Mensah et al., 2022). For example, Chirambo (2018) discloses that school systems within this region lack climate change education content



and material. Apart from this, there is a lack of innovative government systems to help state agencies deliver climate change and sustainability content to the youth (Chirambo, 2018). The UN's pledge not to leave anyone behind, as we seek to change the world for the better, might not be attained if African governments do not proactively seek creative solutions to ensure young people are at the forefront of climate and sustainability efforts (Mensah et al., 2022).

Kenya is a lower-middle-income nation, with a population of about 47.5 million and 12.2 million households (Maritim et al., 2022). Remarkably, three-quarters of this population are individuals aged 35 and below, with the population of those aged between 15 and 34 constituting 36% of the total Kenyan population (Mwaila & Yousif, 2022). The vast population of young people in Kenya and other African nations has been described by Burnett (2014) as a ticking time bomb due to massive unemployment and the propensity for the unemployed to engage in other unproductive activities like substance abuse, unsafe sex, and violence. Unquestionably, this is the unique challenge Kenya faces as 80% of crimes in Nairobi are perpetrated by unemployed youth, with many resorting to criminality as the primary source of livelihood (Kibichii & Mwaeke, 2024). Kibichii and Mwaeke (2024) narrate how these criminal gangs waylaid victims during early mornings and late nights as they leave their jobs. Indeed, the violent attacks and property breakings are more pronounced in slums like Korogocho and Kibera, where there are widespread unemployment and a lack of adequate police surveillance and reach.

Remarkably, all hope is not lost, as Oyeniyi et al. (2024) show, the inherent risks presented by the youth can also present a unique opportunity for the continent, as the creativity and energy of these young people can be harnessed to drive and attain socioeconomic growth and development. Indeed, there are many challenges facing young Africans, including unemployment and a lack of specific development skills. However, as this case study demonstrates, young people can have a positive impact on the local and global agenda on climate change and sustainability. Kenyan youths, as evident in the KOMB Green Solutions initiative, can develop innovative solutions that could save millions of dollars in conservation efforts and deal with climate change issues that have become nearly impossible to resolve.

1.2 Problem Statement

The contamination and pollution of urban river water is a common problem in African and beyond. For example, in the UK, Vane et al. (2022) highlighted how sedentary organic pollution continued to affected River Thames. In the United States, Davis et al. (2024) explored how Mississippi River and its basin were polluted by plastics and other materials from households, farms, and industries. In Asia, specifically, China, authors have revealed the ongoing pollution of the mighty Yangtze and its critical ecosystem (Chen et al., 2022). In the African context, Nephale et al. (2021) focused on urban rivers within South Africa, explaining how pollution has remained a consistent problem and a major health risk for humans and animals. Fortunately, other nations, for example, in Europe, have made tremendous steps in reducing pollution and restoring original ecosystems (Frantzeskaki & Malamis, 2025). Regrettably, Kenya remains behind in conservation efforts, especially those focusing on urban river basins. Nana et al. (2022) citing similar frustrations suggests that the continued biodiversity decline in Africa and failure of successive interventions is due to top-down approaches to management. Besides, Nana et al. (2022) lament that the focus on imposing bans and restrictive rules have failed to bore fruits. Sustainability efforts, especially those sponsored by governments and donors, often have misaligned values and require the great involvement of local actors. Briefly, the



emphasis on top-down approaches and the lack of local actors in conservation efforts is the primary reason why sustainability projects in Kenya and most African nations fail.

1.3 Research Objectives

This case study has the following objectives:

- i. To document how KOMB Green Solutions has transformed Korogocho through the use of locally available resources.
- ii. To explore why successive governments have failed in rehabilitating the Nairobi River Basin.
- iii. To identify the success and barriers related to youth-led sustainability projects in urban contexts.

2. Literature Review

2.1 Theoretical Framework

This case study is anchored on three crucial theories. First, the Participatory Development Theory is a crucial paradigm that has become the cornerstone of local involvement. The highlighted framework opposes the ethnocentric and top-down approach in development. Instead, this theory promotes the bottom-up process, where actors empower community members to take a more active role in the development of their agendas (Hofisi, 2014). The theory is useful in this analysis since it suggests that local ideas are more effective and practical and result in a sense of community ownership. Second, the Social Innovation Theory focuses on the processes by which local communities create new social relations and also becomes more capable of addressing social needs (Mulgan, 2012). This framework shows the central role of local actors and processes in driving change. Hence, it emphasizes the need for local economy entities and civil societies in leading the development of new solutions and fostering collective action. Lastly, Actor-Centered Power (ACP) is a useful theory that could also be applied with other typologies to help understand power dynamics in a community-based initiative (Zhao et al., 2023). ACP acknowledges the role of local actors, who possess power and understanding, which could help influence outcomes. Collectively, the three theories place local actors at the centre of changes and emphasize bottom-up approaches to ensure that new initiatives are embraced by locals and benefit from their support.

2.2 Literature Review

2.2.1 A Brief History of Korogocho Slum

Korogocho was formed through the amalgamation of six villages: Grogon, Ngomongo, Gitathuru, Highridge, Nyayo, and Korogocho. The slum is located on the eastern side of Nairobi City, about 12 kilometres from the city centre (Wangaruro, 1988). In 1988, the slum had a population of 35,000 people and this has grown immensely over the decades to the current population density of 42,401 individuals per square kilometre (Wangaruro, 1988; Muchiri & Opiyo, 2022). Korogocho is the fourth largest slum in Nairobi, with many residents paying for their accommodation (Muchiri & Opiyo, 2022). The slum covers about 40 hectares and borders the Nairobi River. Apart from this, Korogocho also borders the Ruaraka industrial area towards the east and Kariobangi sewage treatment works to the west. Korogocho remains infamous for having substandard housing units, which consist of mud and wattle walls and shanties covered with corrugated iron sheets, polythene papers, and cartons.



Korogocho did not exist before 1970 (Wangaruro, 1988). The region was home to many quarries that were crucial in building the rapidly growing Nairobi metropolis. Before the formation of this settlement, quarry workers built temporary housing units that usually fell apart after some time. Remarkably, a few individuals opted to brew illegal alcohol since the area was remote and far from police surveillance (Wangaruro, 1988). The land at the time was largely owned by the government and would revert to private ownership much later (Muchiri & Opiyo, 2022). Korogocho, as a name, was derived from a nickname of an older adult, who, once drunk, urged his friends not to torment him with questions and quarrels (Wangaruro, 1988). The local village chief would later appoint Mr. Korogocho to become a village elder.

In 1971, the government demolished a slum called Baba Dogo, which was situated in Ruaraka (Wangaruro, 1988). The people who lost their homes were eventually resettled in Korogocho at Ngomongo. In the 1970s, the government continued to demolish slums near the city centre as it intensified efforts to improve Nairobi's overall appeal as an international destination. For example, High Ridge slum was destroyed to enhance the city's image, and the affected persons were resettled in Korogocho (Wangaruro, 1988). Between 1978 and 1979, the Kirinyaga Road slum and Grogan slum were also demolished to pave the way for redevelopment, and the affected families were later resettled in Korogocho.

Undeniably, the formation of this slum underscores the twin problem of poor governance and planning in urban regions, especially in Africa. A study estimates that a quarter of the Kenyan population live in urban areas, with Nairobi having at least 40 designated slum areas (Hussein et al., 2023). Unfortunately, 56% of all residents in Nairobi live in slums, and this situation gets worse due to the exponential population growth (Hussein et al., 2023). The proliferation of slums in Nairobi is a significant issue, as these areas account for only 5% of the city's residential capacity but are home to over 60% of the population (Hussein et al., 2023). The ad hoc resettlement of displaced persons during the redevelopment period, poor resource mapping, and the lack of political goodwill to address housing shortages in Nairobi gave birth to Korogocho, which is one of the largest slums in Nairobi.

Significantly, some experts have blamed the colonial government for the mushrooming slums in Kenya during the 20th century. In their book, Ogot and Ochieng note that Nairobi, during the colonial era, was an outcast city, which was full of the African poor (Ogot & Ochieng, 1995). African workers received extremely low wages, and this left those unemployed 'living on their wits' (Ogot & Ochieng, 1995, pp. 35). Criminals lived in these slums, where they formed a republic of their own and police officers were too afraid to make patrols, for example, during the night (Ogot & Ochieng, 1995). According to Burugu (2015), the urban layout represented the colonial government's segregation policy, with slums becoming the sole enclaves for African workers. The development of these slums, concludes Burugu (2015), was through unbalanced allocation of public resources. Unfortunately, this colonial legacy would be perpetuated by successive governments in the independent Kenya, which explains why the Korogocho slum continues to host thousands today.

3. Methodology

The study adopted the desk research methodology due to multiple reasons. Desk research is widely accepted as a research method that allows experts to analyse information that has previously been collected (Pickard, 2013). One of the primary advantages of desk research is the ability to get a wealth of knowledge without spending considerable time and resources on fieldwork (Pickard, 2013). Apart from this, the method might be essential when there is a lot of information about a topic or phenomenon through online resources, databases, and libraries.



In this case study, desk research was instrumental due to the expected delays that could have occurred as the researcher sought ethical board clearance and permits from the National Commission for Science, Technology, and Innovation. The process could have also resulted in significant financial cost that could have derailed the research process.

Indeed, desk research has multiple limitations that the author sought to address throughout the study. For example, there is potential for bias in sources, and data quality cannot be guaranteed (Pickard, 2013). The researcher addressed this by selecting peer-reviewed articles and reports from credible national agencies and organisations. Additionally, the author ensured that the data used was complete and relevant by selecting recent articles when necessary. During this process, the researcher remained objective, ensuring that no biased information was utilised in drawing the case study. All these efforts were instrumental in developing a case study that helps explain how youth-led climate-resilience programs can help Kenya and Africa to deal with pressing environmental and sustainability challenges.

4. Results and Findings

4.1 KOMB Green Solutions

The development of African cities into sustainable metropolises depends on homegrown solutions that will help address past and emerging challenges. The rise of protectionism in most Western nations, for example, the United States, means that sustainability programs focusing on informal settlements are at risk of coming to a painful stop. The abrupt end of United States Agency for International Development (USAID) and its programs, for instance, which benefited Kenya and many African nations, is a recent example that underpin the need for homegrown solutions for local problems. The new reality is a sobering call for local leaders to explore new and grassroots-based solutions to addressing environmental challenges, including river pollution and indiscriminate dumping. Fortunately, as this case shows, the humble beginning of KOMB Green Solutions and its continued success demonstrate that this is attainable in the long run.

KOMB Green Solutions is a relatively new outfit, having been formed in early 2017 (Citizen TV Kenya, 2025a). Moses Muchina was one of the first members of KOMB Green Solutions. Previously, Muchina was an armed robber and was notorious in the Korogocho slums (Bwire, 2019). According to Muchina, the primary targets for him and his criminal friends were mobile phones and handbags. At the time, Korogocho was a crime hotspot, and most people were afraid to walk after dark. However, in 2017, Muchina had to abandon his criminal behaviours following massive operations by security agencies and mob lynching of suspected criminals (Bwire, 2019). Indeed, Muchina argues that most of the affected young people could have been reformed if they got meaningful jobs.

Muchina spent several months in prison due to a gun possession charge and while there, attended police-led reform programs for ex-gang members. After his release, he then decided to engage in construction activities and picked masonry skills. During this time, Muchina realised the sorry state of his local area, within Korogocho, as garbage was piling up (Bwire, 2019). He asked for multiple volunteers to help clean and make the local park usable. Frederick Okinda took up the offer and worked closely with Muchina. Okinda, the co-founder of KOMB Green Solutions, had also engaged in criminal activities. Okinda reveals that he had seen most of his classmates with wads of money and was tempted to engage in criminal acts (Bwire, 2019). However, he decided to walk away from crime when he lost his tenth friend to



a police shooting. He ended up in a police forum, and where he met Muchina, who would later become his partner in cleaning the environment.

Frederick Okinda formed this community-based organisation in partnership with Muchina and 16 other youths who had previously been involved in crime. Okinda also reveals that the group comprised former prostitutes (Public Space Network, 2024). At the core of this group was the desire to break from a dark past and forge a group that would help transform Korogocho. The primary objective of KOMB Green Solutions was to restore the highly polluted Nairobi River. During the first few years, the organisation worked with many volunteers, who dedicated themselves to improving their environment (Public Space Network, 2024). However, KOMB Green Solutions would also benefit from the benevolence of state and non-state actors, who provided funds to improve their environmental protection work.

Unfortunately, the primary challenges that KOMB Green Solutions faced during the first few years were how to make operations beneficial to reformed youth. Okinda narrates the daunting task of ensuring that young people, who volunteered to clean the river and surroundings, had food on the table once they retreated to their homes (Citizen TV Kenya, 2025a). Indeed, this was instrumental in ensuring that the volunteers did not succumb to the pressure of unemployment and go back to crime. Fortunately, some community-based organisations like Muungano wa Wanavijiji, Public Space Network, and other partners came on board and offered both resources and mentorship to the reformed youth (Public Space Network, 2024). To date, these partnerships have allowed KOMB Green Solutions to spread its influence not only through Korogocho but across Nairobi, ensuring that young people do not engage in crime but take an active role in preserving the environment.

Indeed, Okinda is a role model to many young people, having also walked away from crime. Okinda provided an emotional narrative of how many young Kenyans in slums are forced to become criminals to survive (Public Space Network, 2024). Regrettably, this life is dangerous, with many young people realising this too late when they are incarcerated, injured, or lost their friends. Okinda reveals that he lost his brother due to crime, and as disclosed, he also lost many close friends. However, he reveals that he got a second chance and decided to turn over a new leaf. In fact, Okinda and his group christened a reclaimed Korogocho land, the Garden of Second Chance, confirming that reforming and leaving criminal acts could allow young people to lead better and meaningful lives.

Okinda has lived in Korogocho for over 32 years, making him highly knowledgeable about the core challenges affecting the area and young people (Public Space Network, 2024). Unlike foreigners or Kenyans living in relatively better areas who visit Korogocho in attempts to help locals, Okinda understands the root causes of many issues and has a personal connection to young people whom he has either seen grow or have become friends through his conservation work. He indicates that the word 'Komb' is a local interpretation of the term 'comb,' which entails working to assist all youths in crime in Korogocho and other slums across Nairobi. His mission is to ensure that these reformed young people participate in environmental conservation activities as an alternative means of earning a living and also taking care of their natural surroundings.

One of the significant projects that KOMB Green Solutions has undertaken was the creation of Korogocho's People Park. The land was once a dumpsite, where people would throw away plastic bags and other waste materials (see Figure 1). The riparian land belongs to the



government, and the organisation saw the need to rehabilitate it. Okinda and many volunteers worked for months to remove waste and debris from this location (Public Space Network, 2024). After this process, the organisation planted bamboo trees and flowers, which made the area beautiful and liveable for everyone. The project became a major success for KOMB Green Solutions, with local and foreign entities providing funding and partnership. Today, children play in this park, while adults can take rest under the cool shadows of the well-maintained bamboo trees and lush green spaces. The organisation also developed new revenue-generating activities in this area, including urban farming, aquaponics systems, and agroforestry.



Figure 1: A picture showing the transformation of the dumpsite into the People's Park.

Source: KOMB Green Solutions (2020)

Indeed, proximity to the Nairobi River means that many residents of Korogocho suffer from occasional flooding. The government has reacted to this challenge by requesting residents to vacate their homes and move to higher ground and even demolished some structures (Public Space Network, 2024). In contrast, KOMB Green Solutions responded to this chronic challenge by constructing gabions in certain sections of the Nairobi River, which were instrumental in reducing flash floods in these areas (Public Space Network, 2024). These activities also involve youth advocacy and engagement with residents on the importance of protecting natural resources. The advocacy programs also include involving young people from other communities across Nairobi to benchmark and explore how they can implement these solutions in their locations. Undeniably, this is a classic example of how locals can adapt climate-resilient actions to avoid loss of lives and livelihoods in the future.

KOMB Green Solutions has partnered with the Danish Embassy, Public Space Network, and other entities to transform various parts of Korogocho. Specifically, the organization is targeting an area that was demolished due to the flooding incidences that affected this slum



in late 2024 (Public Space Network, 2024). Okinda and his partners are keen on bringing other young people on board to ensure that the success of this project is also replicated in different slums in Nairobi. The continued success of KOMB Green Solutions confirms the need for state and non-state actors to actively involve young people in conservation efforts and focus on developing unique solutions to ensure that reformed young people stay away from crime while meeting their daily economic needs.

The success of KOMB Green Solutions is also reflected in the achievements of other members. Lilian Ogola, the chairlady, revealed that the organisation has drawn many women from various parts of Korogocho. Lilian intimates that most of these women were initially selling illegal drugs, cheap alcohol, and engaging in prostitution within the slum (Bourn, 2022). Those who were not involved in these acts were forced to do menial jobs to survive the harsh economic times. Lilian, Ann Wangui (Programs Coordinator), Celine Anyango (Treasurer), and other female leaders have focused on mentoring young girls. For example, Ann Wangui has an acrobatic group and recruits young girls to keep them engaged and ensure that they get income through their learned skills (Bourn, 2022). The group also donates sanitary towels and engages with young people on safe sexual practices and family planning to prevent teen pregnancies and the resulting high rates of unsafe abortion.

Remarkably, the garden that KOMB Green Solutions created is a crucial source of vegetables for members of this group and other beneficiaries. The organisation has been using the vegetables from this farm to support a feeding program for vulnerable children and young people (Bourn, 2022). The remaining vegetables are sold to the local market at an affordable rate. The organisation started the feeding program during the Coronavirus pandemic, feeding children and families a sumptuous lunch every Saturday (Bourn, 2022). KOMB Green Solutions has also embarked on poultry and pig farming to boost its income. Mentorship programs are regularly organised to ensure that children and youth understand the importance of environmental conservation.

KOMB Green Solutions also operates a bakery, utilising waste materials collected in the cleaning exercises to heat the locally developed ovens. The bakery employs at least six people, including bakers and others who engage in marketing activities to increase sales (Citizen TV Kenya, 2025b). However, the group complains that the oven is small and cannot match the demand for its products. Elina Onyango, the treasurer in this department, urges the Kenyan government and well-wishers to provide resources to expand the bakery, ensuring it employs more young people and delivers high-quality products across Nairobi. The chairperson reveals that KOMB Green Solutions currently employs about 150 women and 200 young men in Korogocho (Citizen TV Kenya, 2025b). The organisation also aims to start a transport company to ease mobility in and out of this slum.

The success of KOMB Green Solutions is evident from the national government's recognition of this group. In March 2025, President William Ruto visited Korogocho and was hosted by KOMB Green Solutions (Citizen TV Kenya, 2025b). The president launched the Climate Works Initiative in Korogocho, with the visit reigniting the passion of many young people who had volunteered under KOMB Green Solutions. A Citizen TV report narrated how young people had transformed mountains of trash into thriving gardens that many residents now enjoy at Korogocho (Citizen TV Kenya, 2025b). The project was showcased as a symbol of resilience and hope, especially in slums, which are characterised by crime, pollution, and poor living conditions. Faris Kahuha, the chairperson, claims that the crime rate in the area has



plummeted as young people engage in conservation and other activities supported by KOMB Green Solutions.

Despite the successes, KOMB Green Solutions faces multiple challenges. For example, despite efforts to manage waste materials, garbage still accumulates on the Nairobi River. Apart from this, some developers continue to channel sewage water into the river, and this affects irrigation and other rehabilitation activities (Citizen TV Kenya, 2025b). Government inaction has also been blamed for slowing conservation efforts and the process of rehabilitation. For example, Robert Muchiri, a program officer at KOMB Green Solutions, reveals that the government has allocated tenders to wealthy and well-connected individuals, rather than empowering the youth (Citizen TV Kenya, 2025b). Muchiri laments that most individuals assigned to these projects lack an adequate understanding of the key issues facing Korogocho residents. Faris Kahuha discloses that KOMB Green Solutions utilises its limited resources to buy tree seedlings and other materials to protect reclaimed land.

4.2 Succeeding where the State has Failed

The case reveals how former criminals and prostitutes with limited financial resources and tools have succeeded in rehabilitating sections of the Nairobi River and its riparian lands around Korogocho. Nairobi River is the primary source of the River Athi, with up to 4 million people relying on this water system for irrigation and other domestic uses (Njuguna et al., 2017). Unfortunately, raw sewer, industrial pollution, and agricultural effluents levels in this river are alarming. Researchers have found that the Nairobi River contains heavy metals and nutrients that exceed those recommended by the World Health Organisation (WHO) (Njuguna et al., 2017). In fact, observations by Kinyua and Pacini (1991) in the 1990s revealed that some plants in contact with the river were corroded and damaged. Indeed, the two studies affirm that pollution and environmental degradation around the Nairobi River are not a new development.

Before the colonial period, the Nairobi River was a crucial landmark that acted as a boundary between the Maasai and Agikuyu communities (Njenga, 2025). The river, which originates from the Ondiri Swamp, was surrounded by lush vegetation, teeming with birds and other wild animals. Unfortunately, as early as 1902, raw sewage, solid waste, and effluents from the emerging industries in the region and settlements began to enter the Nairobi River. Indeed, this development was also evident in Britain, when the River Thames became highly polluted following human settlement (Mann, 2013). In 1865, the situation was dire, prompting the British government to form a Select Committee on the River Thames. The committee disclosed that pollution has become more severe, making navigation in this river almost impossible and leaving solid matter that had blocked waterways (Mann, 2013). Hence, it was not surprising that this disregard for the environment was evident in Nairobi following colonial settlement at the turn of the 20th century.

The colonial government did not have a plan to rehabilitate the Nairobi River even after decades of pollution and neglect. Regrettably, the anthropogenic effects of this pollution began to be felt in the 1960s and intensified between the 1970s and 1990s (Rosetta, 2008). The problem became worse due to several factors, including industrial growth, high rate of urbanisation, population increase, the poor maintenance of municipal sewage disposal and treatment, development of large informal settlements, and an increase use of agrochemicals in the thriving agricultural sector. Most slums in Nairobi, including Korogocho and Mathare,



are built along the banks of rivers, with slum dwellers directing raw sewage, solid waste, and garbage into these rivers (Rosetta, 2008). The lack of toilets in these locations has compelled some people to defecate on plastic bags and throw them into rivers or surrounding farmlands.

Unfortunately, there is limited information regarding any programs that were instituted by the first Kenyan administrations—Jomo Kenyatta and Daniel Moi governments. However, in 2003, the Mwai Kibaki administration sought to beautify and landscape the riparian zone throughout the Nairobi River Basin. The program was rolled out in two phases: phase 1 (2003-2006) and phase 2 (2006-2009) (Urban Nature Atlas, 2024). The efforts focused on filtering pollutants before they entered the water and controlling soil erosion through the replanting of flora and indigenous trees along riverbanks. Unfortunately, one of the crucial challenges was the encroachment of riparian land, with many people building within riparian buffer zones, especially in slums. According to Urban Nature Atlas (2024), the overall cost of this program was KES 1.4 billion from the national government and an additional \$147,000 provided by the United Nations Environment Programme (UNEP).

In 2017, in another attempt, President Uhuru Kenyatta launched the first phase of the Nairobi Regeneration Programme. President Kenyatta allocated massive resources and even threatened government officials with sacking and legal actions if raw sewage and industrial waste continued to flow into the Nairobi River (Cheruiyot, 2025). During the Uhuru Kenyatta administration, there were different river clean-ups. Indeed, this occurred since the government believed that the polluted river would make the Thakwe Dam, built downstream, a white elephant (Omulo, 2021). In 2019, the government had earmarked approximately 200,000 housing units to be demolished as part of the Nairobi River regeneration project (Kabukuru, 2019). The administration spent over KES 800 million (\$7.8 million) in this regeneration program (Kabukuru, 2019). Despite all these attempts, the program was not successful when President Kenyatta retired in 2022.

His successor, President William Ruto, has vowed to restore the Nairobi River to its former glory. President Ruto started by launching the Nairobi River Commission (NRC) in 2024, through the Gazette no. 13907 of 25th October (NRC, 2025). President Ruto has allocated 50 billion to the new regeneration program, which seeks to employ over 20,000 young people (Realtime, 2025). President Ruto also promised to build affordable houses on some of the reclaimed land and demolish structures constructed on riparian grounds. Unfortunately, as recent history has shown, regeneration programs for this river have cost billions of shillings without any tangible effects.

5. Managerial Implications – The Youth as Bearers of the Vision of the Future

The Kenyan saying that 'Young people are the leaders of tomorrow' cannot be applied to sustainability or environmental conservation efforts, given that the statement implies that young people should be at the periphery in matters that will ultimately affect their future. In fact, this maxim goes against the UN definition of sustainability, which entails meeting the current needs without compromising the ability of future generations to meet their needs. Unfortunately, many sustainability programs that the Kenyan government or major non-governmental organisations have launched have not actively involved the youth. Most meetings occur at the upper executive levels, where young people are either not represented or underrepresented. The outcome has been massive failures in state programs that have been launched to protect the environment, and the preceding paragraphs attest to this challenge.



Undeniably, at the heart of sustainability and conservation efforts is the need for state and non-state actors to adopt grassroots, youth-led conservation approach. KOMB Green Solutions has attained a significant milestone in converting areas that were once full of garbage and raw sewage into havens of green spaces, where local communities can enjoy, and earn their livelihoods. The explained attainments have occurred despite young people having limited resources and resorting to ingenious ways of resolving significant challenges affecting them. Besides, as the case demonstrates, the government and other partners have come at the tail end, with empty promises of funding young people to ensure that they continue with conservation efforts.

Interestingly, the Kenyan example demonstrates the painful state of corruption in conservation and sustainability programs targeting public spaces. For years, the government has allocated billions to regenerate the Nairobi River. However, most of these funds have ended up in the pockets of a few wealthy and well-connected professionals who have done little to help individuals living in Korogocho and other slums. Massive sustainability programs led by the state have been designed to siphon public resources, while leaving fewer resources to young Kenyans engaged in conservation efforts. The top-down approach to this challenge has failed to bear fruit, and this demands that the Kenyan government explore how it can empower local youths, who are knowledgeable about challenges facing their areas.

The example of KOMB Green Solutions demonstrates how young people can conserve the environment and also attain multiple UN Sustainable Development Goals (SDGs). For example, the employment of many youths at the bakery and gardens has allowed this organisation to reduce poverty in Korogocho (Goal 1). The Saturday lunches organised by the entity have dealt with the issue of hunger, while the garden provides a steady flow of vegetables (Goal 2). The project also helps clean the river, and this is crucial in attaining the sixth SDG of clean water and sanitation. A clean environment at Korogocho due to these conservation efforts has also promoted economic growth and decent work for many young people (Goal 8). The efforts have reduced inequalities at Korogocho (Goal 9), institute climate action (Goal 13), promote life on land and water (Goals 14 and 15), and promote partnerships for goals (Goal 17).

6. Conclusion and Future Research

Indisputably, the vision for the future Earth lies in empowering young people to deal with pressing environmental and sustainability issues. Adopting a bottom-up, community-based approach to addressing chronic ecological challenges is the most feasible way to tackle the long-term problems. The case reveals that pollution around Nairobi, and specifically the Nairobi River, started in the early 1900s. Unfortunately, the colonial government and the successive independent Kenyan government have failed to resolve this challenge successfully. Indeed, this has occurred despite the state and non-state actors spending billions of shillings in various phases of cleaning and regenerating the Nairobi River Basin region. KOMB Green Solutions demonstrates that the solution lies in youth empowerment and sensitisation, which allows young people to take initiative and develop innovative solutions to address sustainability challenges affecting them. In the end, the future of the planet is in the hands of young people who are likely to be affected if they are left on the periphery.

Future research in this area is required to compare the long-term effectiveness and cost-efficiency of bottom-up, youth-led environmental initiatives versus top-down, state-led interventions in addressing chronic pollution in other similar urban rivers. This would provide



empirical evidence for policy shifts. Besides, future studies could explore the scalability of the KOMB Green Solutions model to other polluted river systems or different environmental challenges. Empirical studies could also investigate the socio-economic and environmental impacts of youth empowerment and sensitisation programs on community well-being and biodiversity.

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The influence of project leadership on the success of women-empowerment multi-national projects in Rwanda: A case study of the PROFIFA project

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Abstract

This quantitative study examined the influence of project leadership factors on the success of women-empowerment multi-national projects in Kigali, Rwanda, focusing on the PROFIFA initiative. Using a descriptive and correlational research design, data was collected from 338 respondents selected through proportionate stratified sampling. Structured questionnaires generated quantitative data, which were analysed using SPSS version 27 through descriptive statistics and multiple linear regression. The study assessed three core project leadership dimensions, namely, project marketing, project financial management, and project monitoring and evaluation, and their relationship with indicators of project success, including income, project growth, employment creation, membership growth, and improved standards of living. Results demonstrated strong positive relationships across all variables. Project marketing showed a substantial but comparatively lower contribution to project success. Project financial management exhibited a stronger correlation, underscoring its importance in promoting financial stability and informed resource use among women beneficiaries. Project monitoring and evaluation emerged as the most influential variable, reflecting its critical role in tracking progress, informing decisions, and improving project outcomes. The overall model was statistically significant ($R = 0.865$, $R^2 = 0.748$; $F = 46.031$, $p < 0.05$), confirming that the combined leadership variables explained 74.8% of the variance in project success. The findings highlight that strengthening monitoring and evaluation systems, enhancing financial management capacities, and improving targeted marketing practices can substantially advance the performance and sustainability of women-empowerment projects. These insights provide evidence-based direction for policymakers, project leaders, and development practitioners working to enhance women's economic empowerment through structured project leadership interventions.

Keywords: project financial management, project leadership, project marketing, project monitoring and evaluation, Rwanda, women empowerment

Introduction

Background



Women's empowerment has become a central pillar in sustainable development discourse, particularly in emerging economies where gender disparities continue to shape social and economic participation (Agrawal et al., 2023). Empowerment initiatives assist women in acquiring skills, financial resources, and opportunities that enhance their agency, livelihoods, and capacity to contribute to community development (Caruso et al., 2022). In Rwanda, women empowerment is embedded within national development strategies and is supported by both government and non-governmental organisations through targeted interventions designed to increase income, employment opportunities, and financial inclusion (NST2, 2023). The PROFIFA project in the city of Kigali reflects this national commitment by providing women with training, financial support, and opportunities to establish or grow income-generating activities (Usanase & Nkechi, 2022). Despite such efforts, the success of empowerment projects varies widely depending on the strength of project leadership, availability of resources, and systems that guide planning and implementation (Abou-Shouk et al., 2021).

Project leadership is increasingly recognised as a critical determinant of project success, especially in contexts where stakeholders rely on structured management, timely communication, financial accountability, and ongoing monitoring (Imam & Zaheer, 2021). Within women empowerment projects, leadership practices shape whether beneficiaries receive adequate training, support, and follow-up. Leadership also influences whether project teams can anticipate challenges, mobilise resources effectively, and adapt operations to ensure projects deliver expected outcomes (Zhao et al., 2021). Project leadership encompasses a set of interrelated components, including project marketing, project financial management, and project monitoring and evaluation. Collectively, these components determine how effectively projects engage stakeholders, manage budgets, promote accountability, and track progress (Whyte et al., 2022).

Project marketing enhances visibility, stakeholder engagement, and the communication of project goals and benefits. It includes promotional activities, market research, communication with beneficiaries, and targeted messaging designed to increase awareness and participation (Stremersch, 2021). Effective project marketing strengthens stakeholder buy-in and improves the alignment between project goals and community needs. Project financial management is equally central to project performance. It involves budgeting, record keeping, cost control, and financial planning, ensuring that financial resources are properly allocated, monitored, and accounted for (Celestin, 2020). Projects with strong financial management demonstrate greater sustainability, better resource utilisation, and improved beneficiary satisfaction (Mang'ana et al., 2024).

Monitoring and evaluation (M&E) form the foundation for accountability and learning in development projects. M&E provides systematic processes for collecting, analysing, and interpreting data to assess whether a project is meeting its intended objectives (Olala & Nyonje, 2020). Through continuous monitoring, project teams can detect performance gaps, identify emerging challenges, and introduce corrective measures that enhance project quality and outcomes. The literature further suggests that inadequate monitoring, poor documentation, and lack of timely reporting are major contributors to project underperformance (Okafor, 2021). For women empowerment projects, M&E systems not only track progress but also create opportunities for women to express their needs and participate more fully in decision-making.



The conceptual framework for this study positions project marketing, project financial management, and project M&E as independent variables influencing the success of women empowerment multinational projects. Success is defined through indicators such as project visibility, customer awareness, revenue generation, stakeholder engagement, and market share. The relationships among these variables are moderated by government policy, which shapes institutional support, funding environments, and regulatory frameworks. These relationships reflect evidence from prior studies highlighting that these three variables are associated with improved project outcomes (Imam & Zaheer, 2021; Mang'ana et al., 2024; Olala & Nyonje, 2020). However, earlier research has often overlooked the combined influence of project marketing, financial management, and monitoring and evaluation within the context of women empowerment in Rwanda (Abou-Shouk et al., 2021; Celestin, 2020; Usanase & Nkechi, 2022). This study therefore extends the existing literature by focusing specifically on these leadership components and their quantifiable relationship to project success.

Problem Statement

Despite the rapid growth of women empowerment initiatives in Rwanda, many projects continue to face operational challenges that hinder their ability to achieve sustainable outcomes. Evidence from the PROFIFA project in Kigali indicates that while women benefit from training, financial support, and organisational membership, the overall performance of these projects remains inconsistent (Usanase & Nkechi, 2022). Several constraints have been documented, including limited access to capital, inadequate training in financial management, reduced stakeholder engagement, and insufficient marketing strategies to promote project activities. Financial strain in empowerment projects is regularly noted through a lack of access to funding, weak financial management systems, and limited technical support (Abou-Shouk et al., 2021; NST2, 2023).

Project M&E is also highlighted as a major challenge. Although monitoring mechanisms are essential for project success, many women empowerment projects lack adequate systems for data collection, reporting, and feedback (Okafor, 2021). Without reliable and timely information, stakeholders are unable to assess progress, make informed decisions, or ensure accountability. Despite large-scale participation of women in PROFIFA activities, project outcomes such as revenue growth, employment generation, and improved living standards remain limited (Abou-Shouk et al., 2021; NST2, 2023).

Project marketing challenges also contribute to limited project success. When promotional activities and communication strategies are weak, it limits women's ability to attract customers, expand markets, and increase visibility (Celestin, 2020; Stremersch, 2021). While marketing plays a significant role in strengthening project outcomes, its implementation within PROFIFA and similar initiatives has been inadequate, leading to low market penetration and limited awareness of project benefits ((Abou-Shouk et al., 2021; NST2, 2023).

Thus, despite significant investment in women empowerment, project success remains suboptimal because key project leadership functions, namely, marketing, financial management, and M&E, are not adequately integrated or effectively implemented. This gap underscores the need to investigate, using quantitative methods, how these leadership elements influence the success of women empowerment projects in Rwanda to provide evidence-based recommendations for improving performance and sustainability.

Research Objectives



The overall objective of the quantitative study is to examine the influence of project leadership components on the success of women empowerment multi-national projects in Rwanda, using the PROFIFA project in the city of Kigali as a case study.

The specific objectives are:

1. To determine the influence of project marketing on the success of women empowerment multi-national projects in Rwanda.
2. To assess the influence of project financial management on project success within women empowerment multi-national projects.
3. To examine the influence of project M&E on the success of women empowerment multi-national projects in Rwanda.
4. To evaluate the combined effect of project marketing, financial management, and M&E on overall project success.

Hypotheses

Based on the objectives and conceptual framework, the following hypotheses were formulated:

H₁: Project marketing has a statistically significant influence on the success of women empowerment multi-national projects in Rwanda.

H₂: Project financial management has a statistically significant influence on the success of women empowerment multi-national projects in Rwanda.

H₃: Project M&E has a statistically significant influence on the success of women empowerment multi-national projects in Rwanda.

H₄: Project leadership factors (i.e., project marketing, project financial management, and project M&E) collectively have a statistically significant effect on the success of women empowerment multi-national projects.

Literature Review

2.1. Theoretical Framework

The present study is grounded in theoretical perspectives that explain how project leadership practices influence the performance and outcomes of development initiatives such as women empowerment projects. The study identifies leadership-related theories that emphasise coordination, communication, resource utilisation, and accountability as core determinants of project success. These theoretical assumptions are consistent with contemporary project management thinking, which positions leadership as a process through which individuals guide and influence team members to achieve objectives effectively (Aziz et al., 2022; Whyte et al., 2022). Within women empowerment contexts, leadership also facilitates beneficiary engagement, capacity development, and long-term sustainability of project outcomes.

One foundational theoretical perspective underpinning this study is the Contingency Theory of Leadership, which argues that the success of a leader depends on the fit between leadership style, project environment, and contextual constraints. This theory suggests that effective leadership is not universal but is shaped by the demands of the project setting,



including resource availability, stakeholder expectations, and operational complexity Ragavan, 2024). Applied to women empowerment projects, contingency principles indicate that leadership practices such as financial management, marketing, and M&E must adapt to the socio-economic environment of women beneficiaries, many of whom operate in informal or resource-scarce settings.

The study is also informed by Resource-Based Theory, which explains how effective management and utilisation of resources, in this case finances, information, skills, and project tools, determine project success (Zahra, 2021). Financial management, for example, enhances resource allocation, cost control, and transparency, enabling projects to meet strategic objectives. M&E provide informational resources that guide planning, track progress, and support evidence-based decision making. Project marketing serves as a resource through which organizations attract clients, generate participation, and position the project within the broader market environment (Imam & Zaheer, 2021).

Together, these theories provide a robust lens through which the study examines how leadership constructs, such as, project marketing, financial management, and M&E, shape the performance and sustainability of women empowerment projects. Anchoring the study in theoretical perspectives helps justify why leadership factors are expected to have measurable influence on project outcomes, supporting the development of the conceptual framework used in the research.

2.2. Conceptual Literature Review

2.2.1. Project Leadership and Project Success

Project leadership is widely recognised as a central determinant of project success, with numerous studies linking leaders' strategic decisions, communication practices, and management competencies to the achievement of project objectives (Aziz et al., 2022; Imam & Zaheer, 2021; Whyte et al., 2022). Leadership in project environments encompasses planning, budgeting, mobilising resources, coordinating team efforts, managing risks, and evaluating results. In the context of women empowerment projects, leadership is particularly critical because these initiatives often target marginalised populations and require interventions that address economic, social, and cultural barriers (Abou-Shouk et al., 2021; NST2, 2023).

Project success is conceptualised in this study as the degree to which project outcomes, namely, income generation, business growth, employment creation, and improved living standards, are realized (Gemino et al., 2020). Effective leadership enables project teams to set clear goals, manage constraints, and adjust activities to ensure optimal performance. Studies show that weak leadership leads to misallocation of resources, poor communication, limited monitoring, and failure to achieve intended impact (Imam & Zaheer, 2021).

2.2.2. Project Marketing

Project marketing refers to activities that promote the project's objectives, increase visibility, attract stakeholders, and enhance participation (Stremersch, 2021). It includes market research, brand positioning, promotional campaigns, communication strategies, and engagement with beneficiaries (Bizarrias et al., 2020). For women empowerment projects, marketing plays a critical role in increasing awareness among community members and



enhancing the marketability of products produced by beneficiaries (Abou-Shouk et al., 2021; NST2, 2023).

Marketing also helps projects differentiate themselves from competing initiatives and communicate value to donors, partners, and beneficiaries. Many women empowerment initiatives fail to reach expected levels of performance due to limited promotional activities, weak communication, and reduced market penetration. Project marketing therefore influences success by ensuring higher engagement, increased sales, improved product visibility, and stronger beneficiary participation (Ciric Lalic et al., 2022; Roth et al., 2020).

2.2.3. Project Financial Management

Financial management encompasses budgeting, planning, cost control, financial reporting, and record keeping (Celestin, 2020; Mang'ana et al., 2024). In empowerment projects, effective financial management ensures that resources are used efficiently, expenditures are tracked, and funding is allocated in alignment with project goals. Financial accountability builds trust among beneficiaries and donors, increasing the likelihood of project sustainability (Venczel et al., 2021).

Financial challenges, such as limited funding, poor financial literacy among beneficiaries, and weak budgeting systems, are identified as major constraints affecting project success. When financial management systems are inefficient, projects experience delays, cost overruns, or inadequate service delivery. Conversely, projects with strong financial structures achieve better program implementation, enhanced economic outcomes, and improved livelihood opportunities for women (Bezdrob et al., 2020; Kumar et al., 2023).

2.2.4. Project Monitoring and Evaluation

M&E are essential processes for tracking project progress, assessing performance, and determining whether project objectives are being achieved (Olala & Nyonje, 2020). Monitoring involves continuous data collection to measure progress, while evaluation provides episodic assessment of relevance, effectiveness, and sustainability. Together, these processes ensure accountability, transparency, and learning (Okafor, 2021).

M&E allows project leaders to identify implementation gaps, make informed decisions, and adjust project strategies. In women empowerment initiatives, monitoring ensures beneficiaries receive continuous support, training activities are properly implemented, and financial resources are used appropriately (Young et al., 2020). Weak M&E systems are associated with inefficiencies, poor reporting, and reduced project impact (Arif & Bannian, 2022).

2.3. Empirical Literature Review

The study draws on several previous studies to support the research hypotheses. Empirical studies provide evidence on how leadership components influence project outcomes across different contexts.

2.3.1 Empirical Studies on Project Marketing

Bizarrias et al., (2020) demonstrated that project marketing significantly contributes to project performance by strengthening stakeholder relationships and increasing the visibility of project activities. Marketing was found to enhance communication between project leaders and beneficiaries, enabling greater participation and alignment between project goals and



community needs (Cova Salle, 2005; Martens et al., 2018; Obradović et al., 2016). Promotional strategies improve project awareness and influence beneficiary behaviour. The simultaneous use of project and marketing management techniques can significantly improve project quality and reduce penalties and delays (Golob et al., 2013). Successful projects are distinguished by three major elements, namely, a clear strategic vision, total alignment, and adapting to complexity (Shenhar & Holzmann, 2017).

Design thinking in projects is a method to solve complex problems as well as facilitate motivation and empowerment. Researchers have confirmed that psychological empowerment mediates the impact of the application level of design thinking on project performance. This quantitative study done with 160 students participating in 62 innovation projects for companies provides empirical support for the performance relevance of design thinking (Roth et al., 2020). Design thinking at a project level has many advantages. These include improving the connection between individuals in the development process with the customer and facilitating better decision making (Bryant & Wrigley, 2015) and successfully managing various stakeholders in innovation projects and articulating project strategy (Mahmoud-Jouini et al., 2016). Hölzle and Rhinow (2019) indicate that design thinking projects allow teams to go through experiential learning processes and Seidel and Fixson (2013) have confirmed that high-performing teams find design methods more helpful in concept generation and concept selection than low-performing teams. Project teams applying design thinking have also been found to develop better product concepts (Meinel et al., 2020).

In empowerment projects specifically, marketing has been shown to increase women's participation in training, enhance product promotion, and support micro enterprise growth. Weak marketing strategies, however, often result in limited client engagement, low participation, and reduced market penetration, all of which constrain project success (Blair et al., 2024; Thomas & Duffett, 2025).

2.3.2 Empirical Studies on Project Financial Management

Celestin (2020) conducted a study within Rwandan local governments and found that effective financial planning, robust control mechanisms, and capacity-building significantly enhanced project timelines. The recommendations from this study include expanding financial training, adopting financial technology, and strengthening audit practices to sustain these improvements. This supports the findings of Smith (2018) who conducted a study in Kenya focusing on the role of financial planning in ensuring project delivery within the stipulated time frame. Inadequate financial planning often led to delays, a challenge exacerbated by insufficient forecasting tools.

Johnson and Kumar (2019) assessed budgetary allocation processes in India and their impact on project execution. They aimed to determine whether periodic budget reviews could enhance project completion rates. Their conclusion was that streamlined allocation processes significantly reduced delays. A South African study examined the role of financial controls in improving project efficiency. The research's objective was to explore if there was a link between stringent financial monitoring mechanisms and timely project execution. Using information gleaned from five municipalities, Nkosi (2017) highlighted that weak financial oversight often resulted in stalled projects.



The success of enterprises relies heavily on their ability to manage finances effectively (Kumar et al., 2023). A study by Mang'ana et al. (2024) explored the extent to which agricultural SMEs in Tanzania practice financial management activities. The study found that these enterprises frequently engage in working capital management practices, such as maintaining sufficient cash flows and records for payables and receivables. However, financial reporting is less frequently practiced, with sporadic financial statements preparation and financial analysis. SMEs in developing countries should strategise the implementation of financial management practices as this will lead to improved access to finance and high performance. The results also align with similar prior research done in this area (Tharmini & Lakshan, 2021; Venczel et al., 2021).

Cleary and Lamanna (2022) found a strong link between financial management practices and project success, emphasising the importance of budgeting, cost control, and financial accountability. Their findings demonstrate that when projects manage their finances effectively, they tend to perform better, are more sustainable, and achieve greater beneficiary satisfaction. Gunduz and Almuajebh (2020) similarly noted that effective financial systems ensure transparency, reduce misappropriation of funds, and enhance the ability of projects to meet expected outcomes.

In women empowerment contexts, financial management is often a key determinant of the success of income-generating activities, enabling women to access capital, expand their businesses, and achieve financial independence (Mazanec et al., 2022). Self-assessed financial management competencies have significant effects on both the perceived financial and perceived organisational performance of non-profit organisations, with the strategic financial planning competency having the strongest impact on financial performance, and the budgeting competency having the strongest impact on organisational performance (Stühlinger, 2022).

2.3.3 Empirical Studies on Monitoring and Evaluation

Olala & Nyonje (2020) confirmed in a systematic literature review that M&E practices had a statistically significant influence on the performance of projects. Okafor (2021) also confirmed a directly proportional influence of M&E on project performance. Specifically, an M&E plan should be in place to ensure its positive influence on project performance. M&E should be systematically implemented in full for it to influence project performance.

A Kenyan study exploring the influence of four main M&E tool usage on agricultural project success, found that 79% of the respondents confirmed that their usage of these M&E tools had a high extent influence on their project success. The four M&E tools were: mobile applications, logical framework, monitoring and evaluation plan and data dashboard. All four tools showed a strong positive correlation with project success. The results revealed that 83.2% of the changes in project success could be explained by the usage of these M&E tools (Charles & Senelwa, 2018).

Project performance is of critical importance to project managers and stakeholders as it measures the return on investment. A study by Thambura et al. (2023a) sought to explore the combined influence of M&E practices on the performance of livelihood development programmes in Kenya. The 196 respondents confirmed the significant influence on these



practices on the performance of these programmes. Most of the respondents linked the programme's performance to M&E practices, including M&E data collection (94.6%), M&E planning (94.6%), and M&E knowledge sharing (95.1%). The significance of M&E practices in determining project performance is also supported by previous studies. Thambura et al. (2023b) confirmed the significant influence of M&E data collection practices on performance. Muchelule et al. (2017) revealed a positive correlation between monitoring of state corporations in Kenya and their performance. Kamau and Mohamed (2015) also established that good project performance is influenced by various factors, with M&E playing a critical role. Similarly, M&E was the main driving factor in the success of development projects and programmes (Singh et al., 2017).

2.3.4 Synthesis of Empirical Findings

Overall, empirical research consistently shows that project marketing, financial management, and M&E positively influence project success. Each leadership dimension contributes uniquely to project outcomes. Marketing enhances visibility and participation, financial management ensures efficient resource use, and M&E strengthens accountability and decision-making. The empirical studies reviewed support the hypotheses examined in this study.

Research Design and Methodology

This study adopted a structured methodology to investigate the influence of project leadership, specifically project marketing, project financial management, and project M&E, on the success of women empowerment multinational projects in Rwanda, using the PROFIFA project in the city of Kigali as a case study. The methodological procedures were guided by established research standards and aligned with the study objectives.

Research Paradigm and Design

The research was anchored in a positivistic quantitative paradigm, which emphasises the explanation of relationships between variables through measurable evidence and statistical analysis. Quantitative paradigms are grounded in objectivist assumptions, using numerical data to test hypotheses derived from theory and literature (Bryman & Bell, 2015). The study adopted a descriptive research design, enabling systematic measurement of the influence of the project leadership components on project success. Descriptive designs allow researchers to describe characteristics and patterns within a population, while quantitative designs test relationships between variables through statistical procedures (Collis & Hussey, 2021). This paradigm and design were suitable because the study sought to quantify the extent to which different aspects of project leadership predict project success within empowerment projects.

Research Approach

The study followed a deductive research approach, which begins with theory, develops hypotheses, and then tests these through empirical observation. This approach aligns with the quantitative paradigm and supports the investigation of causal relationships between project marketing, financial management, M&E, and project success. Deductive approaches require operationalisation of concepts into measurable indicators and emphasize generalisability from sample data to the broader population (Creswell & Creswell, 2022). The study on quantitative operationalisation to enable measurement.



Research Method

The study utilised a survey research method, which is commonly applied in quantitative social research to gather data from a large population efficiently. Structured questionnaires were used to obtain primary quantitative data. Surveys provide standardised responses that enable descriptive and inferential statistical analysis (Bryman & Bell, 2015).

Population and Sample

The target population comprised 2,180 women beneficiaries of the PROFIFA project in the city of Kigali, including women trained, women given loans, cooperative members, and project team leaders. From this population, the sample size was calculated using Yamane's (1967) formula, resulting in a sample of 338 participants. The sample ensured representativeness across beneficiary categories, with proportional allocation as follows: 93 trained women, 171 loan beneficiaries, 62 cooperative members, and 12 project team members. Simple random sampling ensured equal selection probability among the beneficiary categories (Creswell & Creswell, 2022).

Research Instrument

The primary research instrument was a structured questionnaire, comprising open and closed-ended items aligned with the specific objectives of the study. Questionnaires are efficient tools for collecting large amounts of data within a short timeframe and allow the researcher to quantify responses for statistical analysis. According to Collis and Hussey (2021), primary data collected directly from respondents provides reliable evidence for assessing perceptions and experiences. The questionnaire was developed based on the study variables, namely, project marketing, project financial management, project M&E, and project success.

The questionnaire was made up of five sections. Section A asked three demographic questions, namely, age, highest level of education attained and current occupational type. Section B comprised of six statements exploring project success, section C entailed four statements on project marketing, section D had five statements on project financial management, while section E contained five statements on project M&E. The statements in sections B to E were of a Likert-style.

Data Collection and Analysis

Data collection procedures adhered to university guidelines. The researcher obtained consent from the respondents and ensured confidentiality before administering the questionnaires. Completed questionnaires were checked, edited, and coded for accuracy and completeness.

Data processing involved classification, coding, and tabulation to prepare the dataset for analysis. The quantitative data was analysed using SPSS version 27, employing both descriptive and inferential statistics. Descriptive analysis included frequencies, percentages, means, and standard deviations, which summarised participant responses. Inferential analysis included correlation and multiple regression, allowing examination of the strength and direction of relationships between independent and dependent variables.

Ethical Considerations

The study complied with ethical research standards by securing permissions from relevant authorities and ensuring protection of participants' rights. Respondents were informed of the



purpose of the study, assured of confidentiality, and advised that participation was voluntary. The researcher followed institutional ethical guidelines, protected participants from harm, and ensured that information was used solely for academic purposes. Confidentiality, informed consent, and respectful handling of sensitive information were key ethical priorities.

Results and Findings

This section presents the quantitative results of the study examining the influence of project leadership, operationalised through project marketing, project financial management, and project M&E, on the success of women-empowerment multinational projects within the PROFIFA initiative in the city of Kigali, Rwanda. Results are organised around descriptive statistics, correlation analyses, regression findings and variable-specific outcome patterns.

Response Rate

A total of 342 questionnaires were distributed to women participating in the PROFIFA project. Of these questionnaires, 4 were poorly completed and discarded, resulting in an effective response rate of 98.5%, surpassing the 70% rate widely considered acceptable for survey research. This high response rate enhances the reliability and generalisability of the study's findings.

Demographic Characteristics of Respondents

In this section, three characteristics of the respondents are explained, namely, age, educational level and type of occupation held by the respondents.

Age Demographics

Respondents ranged from 18 to above 50 years. As indicated in Table 1, the largest age group was 30–39 years (36.9%), followed by 40–49 years (28.9%), 18–29 years (26.3%), and those above 50 years (7.6%).

Table 1: Frequency Table on Age

Age (Years)	Frequency	Percentage
18-29	89	26.3
30-39	125	36.9
40-49	98	28.9
50 and above	26	7.6
Total	338	100

Source: Authors' compilation

Women aged 30–39 years of age appear to be most engaged in PROFIFA activities, while participation decreased in the older age categories. This may be due to increased family responsibilities and reduced involvement in community-based economic projects.



Educational Level Demographics

The highest education levels attained by the respondents varied considerably. Table 2 depicts this distribution across the five options provided. Those respondents who had acquired primary education grades 5 - 8 formed the majority group with a frequency of 98 (28.9%). The second largest grouping were those that had no formal education or had pre-school education with a frequency of 78 (23.1%). Those who had acquired secondary school education comprised the third largest grouping with 57 respondents, 16.8% of the sample. Those respondents who had acquired primary education grades 1 - 4 formed the fourth largest group with a frequency of 54 (15.9%). The smallest group were those who had attained university and or college education, making up 15.1% of the sample.

Table 2: Frequency Table on Educational Level

Educational level	Frequency	Percentage
Pre-school and no schooling	78	23.1
Primary: Grade 1-4	54	15.9
Primary: Grade 5-8	98	28.9
Secondary	57	16.8
University and college	51	15.1
Total	338	100

Source: Authors' compilation

These results suggest that although many women have basic education, fewer have progressed to higher education, a factor that may influence project engagement and leadership capacities.

Occupational Demographics

The majority (58.2%) of the respondents were self-employed. Table 3 also indicates that a second large group (26.3%) are housewives. Casual work was the third largest occupational category with 27 respondents enjoying this form of employment. Another 12 respondents indicated they were employed, and 134 stated they were unemployed.

Table 3: Frequency Table on Occupational Type

Occupation	Frequency	Percentage



Employed	12	3.5
Self employed	197	58.2
Housewives	89	26.3
Casual labourer	27	7.9
Unemployed	13	3.8
Total	338	100

Source: Authors' compilation

High self-employment rates correspond with PROFIFA's focus on grassroots income-generation and entrepreneurial capacity-building. The self-employed occupational grouping comprises small businesses such as hawking, retail business and vegetable kiosks.

Correlation Analysis

Correlation analysis was conducted to examine the strength of the relationships between the three leadership components and project performance. The combined results are shown in Table 4.

Table 4: Combined Correlation Analysis Results

Variable Pair				Correlation (r)	Coefficient	Strength
Project Marketing vs. Performance				0.91		Strong
Project Financial Management vs. Performance				0.93		Very strong
Project Monitoring & Evaluation vs. Performance				0.97		Extremely strong
Combined Performance	Independent Variables	vs.		0.94		Very strong

Source: Authors' compilation

These results suggest that although all the leadership factors significantly contributed to project success, M&E plays the most crucial role, followed closely by financial management. These findings link to other research that confirmed the significant influence of M&E on the performance of projects (Charles & Senelwa, 2018; Kamau & Mohamed, 2015; Okafor, 2021; Olala & Nyonje, 2020, Muchelule et al., 2017; Singh et al., 2017; Thambura et al., 2023a; Thambura et al., 2023b).

Regression Analysis



A multiple regression analysis was conducted to determine the combined predictive power of the three leadership dimensions on project success. The model summary is provided in Table 5.

Table 5: Model Summary

R	R	Adjusted R Square	Std. Error of the Estimate
0.865a	.748	.732	1.90103

Source: Authors' compilation

This indicates that 74.8% of the variance in the success of women-empowerment projects could be explained by the three leadership variables discussed in this study.

The ANOVA statistics of the processed data are indicated as a 5% level of significance. The results from this inferential statistic are provided in Table 6.

Table 6: ANOVA Results

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	332.704	5	166.352	46.031	.000b
Residual	112.031	91	3.614		
Total	444.735	96			

Source: Authors' compilation

Table 6 shows that the value of the calculated F is 46.031 and the value of F critical at 5% level is 3.61. Since F calculated is greater than the F critical ($46.031 > 3.61$), this shows that the overall model was significant. The results demonstrate that project leadership significantly influences the success of women-empowerment initiatives. The strongest predictor of project success is project M&E, followed by financial management, and lastly project marketing. Despite PROFIFA's efforts, socio-cultural constraints, limited access to funding, and inconsistent record-keeping weaken project effectiveness, hindering the full achievement of empowerment outcomes. The regression model confirms that project leadership factors jointly explain nearly three-quarters of the variation in project success, reinforcing the centrality of leadership competencies in sustaining women-empowerment programmes.

Inferential Statistics: Hypothesis Testing and Interpretation

Inferential statistics, including correlation and multiple regression analyses, were used to test the research hypotheses and determine the extent to which each independent variable predicted project success.

Objective 1: Influence of Project Marketing on Project Success



Hypothesis H₁: Project marketing has a statistically significant influence on the success of women-empowerment projects.

Correlation results showed a strong positive relationship between project marketing and project performance indicators, with coefficients ranging from $r = 0.73$ to 0.96 , including outcomes such as income, project growth, employment creation, membership expansion, and improved standards of living. Although project marketing had the smallest predictive effect relative to financial management and M&E, all observed correlations were statistically significant and consistently high. These results indicate that visibility, communication, and promotional activities contribute meaningfully to project effectiveness.

Conclusion for H₁: Supported.

Project marketing significantly influences project success and fulfils the requirements of Objective 1.

Objective 2: Influence of Project Financial Management on Project Success

Hypothesis H₂: Project financial management has a statistically significant influence on project success.

Financial management demonstrated very strong and statistically significant correlations with project success, with coefficients ranging from $r = 0.89$ to 0.96 . Respondents highlighted limited access to funding, challenges in financial tracking, and inadequate record-keeping as constraints to project performance. These findings underscore the importance of effective budgeting, cost management, and transparent resource allocation in driving project success.

Conclusion for H₂: Supported.

Project financial management is a significant predictor of project success and meets the goal of Objective 2.

Objective 3: Influence of Monitoring and Evaluation on Project Success

Hypothesis H₃: Project monitoring and evaluation has a statistically significant influence on project success.

M&E emerged as the most influential leadership factor. M&E produced the strongest correlation coefficient ($r = 0.97$) and explained the highest proportion of variance in project performance ($R^2 = 94.1\%$). These results show that consistent tracking of project activities, accurate record-keeping, and timely reporting significantly improve outcomes such as income, growth, and employment creation.

Conclusion for H₃: Supported.

Monitoring and evaluation is the strongest individual predictor of project success and fully addresses Objective 3.

Objective 4: Combined Effect of Leadership Factors on Project Success

Hypothesis H₄: Project leadership factors collectively have a statistically significant effect on project success.

Regression Model Summary



The combined effect of project marketing, financial management, and monitoring and evaluation was assessed using multiple linear regression. The model produced:

$$R = 0.865$$

$$R^2 = 0.748$$

$$\text{Adjusted } R^2 = 0.732$$

This indicates that 74.8% of the variation in project success is explained collectively by the leadership variables, demonstrating strong overall predictive power.

ANOVA Results

The regression model was statistically significant:

$$F(5, 91) = 46.031, p < 0.000,$$

confirming that the leadership variables jointly influence project performance.

Regression Coefficients

The resulting regression equation was:

$$Y = 7.470 + 1.015X_1 + 0.054X_2 + \varepsilon$$

Both coefficients were statistically significant ($p < 0.05$), indicating that perceived project effectiveness and empowerment service delivery contribute meaningfully to overall project success.

Conclusion for H₄: Supported.

The combined leadership model significantly predicts project success and fulfils the aim of Objective 4.

Table 7 provides a summary of the findings across the four hypotheses. Across all hypotheses, the inferential statistics show that project leadership plays a decisive role in shaping the outcomes of women-empowerment projects. M&E is the strongest predictor, followed by financial management and project marketing. Together, these variables explain nearly three-quarters of the variation in project success.

Table 7: Summary of Hypotheses Testing

Hypothesis	Statement	Supported?
H ₁	Project marketing → project success	Yes
H ₂	Financial management → project success	Yes
H ₃	Monitoring and evaluation → project success	Yes
H ₄	Combined leadership factors → project success	Yes

Source: Authors' compilation



These findings confirm that strengthening leadership capacities and organisational systems is essential for enhancing the sustainability and impact of empowerment initiatives such as PROFIFA.

Managerial Implications

The findings of this study offer several important managerial implications for leaders, policymakers, and implementing agencies involved in women-empowerment projects in Rwanda and similar socio-economic environments. The results demonstrate that project leadership, particularly project marketing, financial management, and M&E, plays a pivotal role in determining the success of empowerment initiatives. Managers overseeing such programmes should, therefore, prioritise strategic leadership practices that enhance accountability, strengthen beneficiary engagement, and improve overall project performance.

First, the strong predictive value of M&E underscores the need for managers to invest in robust M&E systems. With M&E showing the highest correlation with project success, managerial teams should adopt continuous tracking mechanisms, develop user-friendly reporting tools, and train both project staff and beneficiaries on basic data documentation. Effective M&E processes allow managers to identify emerging gaps early, adjust implementation strategies, and ensure that project activities remain aligned with empowerment objectives. Strengthening M&E also contributes to enhanced transparency, which helps secure donor confidence and ensures long-term sustainability.

Second, the findings indicate that project financial management significantly influences project outcomes, reflecting the need for improved budgeting, record-keeping, and cost-control practices. Managers should establish clear financial procedures, provide regular financial training to project beneficiaries, and implement digital or semi-digital financial systems to reduce errors and enhance accountability. Given the high proportion of respondents who reported financial strain and inadequate record-keeping, managers should adopt proactive financial-planning strategies to ensure efficient use of limited resources. Developing financial partnerships with NGOs, private-sector actors, and microfinance institutions could also expand access to capital for women beneficiaries.

Third, project marketing showed the lowest, though still strong, effect on project success. This finding highlights the need for managers to enhance communication, market access, and stakeholder engagement strategies. Women-empowerment projects should incorporate targeted marketing campaigns, community outreach, and branding initiatives that raise awareness of available opportunities and products produced by beneficiaries. Managers should promote market research and create linkages with local marketplaces, cooperatives, and digital platforms to improve the visibility and competitiveness of women-led enterprises.

Finally, the overall regression results suggest that leadership factors jointly explain a substantial portion of project success. Managers should therefore adopt a holistic leadership approach that considers financial management, marketing, and monitoring simultaneously rather than independently. Strengthening leadership competencies among project team members, including communication skills, planning, and digital literacy, would further enhance the likelihood of project achievement.



Conclusions, Recommendations, Limitations and Future Research

This study examined the influence of project leadership, namely, project marketing, project financial management, and project M&E, on the success of women-empowerment multinational projects within the PROFIFA initiative in the city of Kigali, Rwanda. The quantitative findings demonstrate that leadership plays an essential role in shaping project performance, with M&E showing the strongest relationship with project success, followed by financial management and project marketing. Overall, the results affirm that strengthening leadership capacities and institutional systems is critical to enhancing the sustainability, impact, and long-term viability of women-empowerment initiatives.

Based on the findings, the following recommendations are proposed for project leaders, policymakers, and implementing organisations:

1. **Strengthen M&E Systems:**

Given its strongest influence on project success, robust M&E systems should be prioritised. This includes developing regular monitoring schedules, training staff and beneficiaries on data collection, and integrating digital tools for record keeping and reporting.

2. **Improve Financial Management Practices:**

Projects should adopt structured budgeting processes, transparent financial reporting, and continuous financial literacy training for women beneficiaries. Partnerships with microfinance institutions, NGOs, and local financial bodies could improve access to capital and reduce financial strain.

3. **Enhance Project Marketing Strategies:**

Targeted promotional campaigns, improved communication, branding, and community outreach are essential to increasing project visibility and participation. Managers should encourage beneficiaries to access wider markets, including cooperatives, local markets, and online platforms.

4. **Address Socio-Cultural Barriers:**

Implement community sensitisation initiatives to challenge gender stereotypes and promote acceptance of women's leadership and economic participation. Engaging local leaders and influential community groups can enhance the effectiveness of these interventions.

5. **Build Leadership Capacities Within Projects:**

Training in leadership, communication, technological skills, and project coordination should be prioritised to empower project teams and improve operational effectiveness.

Although the study provides valuable insights, several limitations should be acknowledged. The quantitative findings rely on self-reported questionnaire data, which may be influenced by respondent bias or inaccurate recall. Data were collected at a single point in time, limiting the ability to draw causal conclusions or assess changes over time. Thirdly, while the sample was sizeable, results may not fully represent all women-empowerment projects in Rwanda. Context-specific factors may limit generalisability. And finally, some constructs relied heavily on perceptions due to the limited availability of documented financial and performance records in the participating projects.



Future studies could expand upon these findings in several important ways. Tracking empowerment projects over time through longitudinal studies would allow researchers to examine changes in leadership effectiveness and project outcomes, providing stronger causal inferences. Comparing PROFIFA with similar empowerment initiatives across Rwanda or East Africa could highlight contextual similarities and differences and broaden understanding of project leadership dynamics. Future studies could use interviews, focus groups, or Participatory Learning Approaches to deepen insight into women's lived experiences, leadership perceptions, and socio-cultural barriers. Research examining how mobile apps, digital finance tools, or digital M&E systems enhance project performance could inform innovative approaches to project implementation. And, finally, future research could incorporate factors such as government policy, technology adoption, or community support to understand how they influence the relationship between leadership and project success.



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Public Administration and Informal Sector: Assessing Effects of Informal Sector Development Policy on Rural Poverty

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Abstract

Contrary to the traditional idea that informality will decline as economies develop, the informal sector has recently come under more scrutiny because it continues to expand even with diverse economic conditions in different countries. In fact, large number of non-agricultural occupations in Africa are in the informal sector, particularly in Sub-Saharan Africa countries like Nigeria. This trend is primarily due to the prevalence of poverty and concerns have been raised by public administrators about the informal sector's ability to reduce poverty. Consequently, this study employed quantitative analytical techniques to assess the effects of informal sector development on rural poverty in Lagos state. Data for the study were sourced from 384 purposely sampled small business owners in Ikorodu and Epe areas of the state. The data collected were analyzed using descriptive techniques while the four hypotheses generated were tested using Analysis of Variance framework. The results indicated that there is direct and statistically significant relationship between informal sector size and rural poverty as well as direct and statistically significant relationship with informal sector activities and rural income. Further findings showed that, informal sector activities exert direct and significant influence on rural poverty in the state. The findings indicate that government policies and programmes aimed at strengthening the informal sector contribute significantly to rural poverty reduction, as evidenced by their statistically significant positive impact. This study recommends that the government need to integrate informal businesses into formal value chains through partnerships with larger firms which can boost their income generating capacity. Also, the government should simplify taxation policies which will encourage their business growth and long-term economic stability.

Keywords: Informality; Rural Poverty; Taxation Policies; Government Policy and Program

Introduction

Background

Contrary to the traditional idea that informality will decline as economies develop, the informal sector has recently come under more scrutiny because it continues to expand even with diverse economic conditions in different countries (OECD/ILO, 2019; Carswell et al., 2026).



Specifically, the informal sector has emerged as a viable alternative to unemployment and a major source of employment, helping to absorb excess labour from rural-urban migration. It also provides income, particularly for the poor (Fox & Sohnesen, 2016). More than 70 percent of non-agricultural occupations in Africa are in the informal sector, which is the main source of employment prospects (ILO, 2018; Fathallah et al., 2026). This tendency is most noticeable in Sub-Saharan Africa (SSA) countries like Nigeria, where, aside from agriculture, the informal sector accounts for the largest percentage of employment (76.8%) (ILO, 2018). Aside from worries about the ongoing increase in the informality rate, there has been much discussion about the sector's capacity to reduce poverty, the factors that encourage people to work informal entrepreneurship (Chen, 2012), and the degree of diversity in the types of work and workers in the sector (Lehmann, 2015; Basu, et al., 2018; Danquah, et al., 2021). Although there are several studies on the connection between poverty and informality in the literature, the most of them have used macro-data to provide a national perspective on the problem (Kanbur, 2017; Laoyza, 2018; Canelas, 2019). Furthermore, there is a dearth of research on the microeconomic effects of the informal sector on poverty in Nigeria. This is especially crucial in the Nigerian context, where data indicates that the informal sector plays a significant role in addressing unemployment and poverty and where informal entrepreneurs create jobs through small enterprises (Eigbiremolen, 2022). analysis from Nigeria to provide new data on the dynamics of informality and rural poverty. Several literature had examined the dynamics of informal employment (Danquah et al., 2021; Lee *et al.*, 2018) and poverty (Barrett *et al.*, 2016; Eigbiremolen, 2018; Balboni *et al.*, 2021; Eigbiremolen, 2022), only a few have focused on micro analysis in the Nigerian context in line with policy arrangement as a developmental tool for a developing nation such as Nigeria. As a result, this study investigates the influence of informal sector development on rural poverty in Lagos state, Nigeria.

Literature Review

This section should contain the three parts: (1) the theoretical framework underpinning the study, (2) a conceptual literature review, and (3) an empirical literature review.

This section outlines the theoretical framework of the study, examining the relationship between rural poverty and informal sector. Also include are findings from reviews of previous studies relevant to this research.

Theoretical Framework

Neoliberal Theory

De Soto first proposed the Neoliberal hypothesis in 1989. Neoliberalism is an ideology founded on economic liberalism. The ideology supports economic policies that minimise the role of the State while maximising the private sector (Francis, *et al.*, 2021). According to the argument, the informal sector emerged as a result of overbearing state rules by public administrators such as multiple taxes and strict business registration processes. The concept of Neoliberalism is built on the premise of wanting to transfer economic authority from the public to the private sector with the intention of resulting into more efficient government and better the nation's economic health. Rahou1 and Taqi (2021) asserted that the informal sector is made up of 'fortunate' micro-entrepreneurs who prefer to operate unofficially to save the expenses, time, and effort associated with formal registration. They stated that microentrepreneurs will continue to produce informally if government procedures remain laborious and costly in terms of bureaucratic red tape, lack of property rights, and limited



access to productive resources like as financing and technology. In his opinion, unreasonable government rules and regulations stifle private entrepreneurship.

Institutional Theory

How formal (regulatory) and informal (normative and cognitive) institutions affect entrepreneurs' behaviour and choices is the focus of institutional theory in the context of this study. This theory is divided into the economic and social schools of thought. According to Scott (2007), DiMaggio and Powell (1991), the sociological school views informal normative and cognitive variables (norms, values, and beliefs) as important driving forces that influence entrepreneurial behaviour but the economic school considered formal regulative factors (rules and laws). Also, formal and informal institutions, shape entrepreneurship and, in certain situations, push it towards informality, which in such manners serve an equally significant factors by influencing behaviour in the developing economies (Posek, 2020). Of a note, dominant theories, including the structural and neo-liberal theories, seem to concentrate mostly on the economic school, which emphasizes formal institutional forces that push people and entrepreneurs towards informality. For example, neo-liberalists see excess bureaucracy and state interference as the cause of informality, whereas structuralists see it as the outcome of insufficient state support and intervention (Dell'Anno, 2022).

Effects of rural poverty on Informal sector

All forms of empirical research concur that the informal sector is sizable and contributes significantly to employment in emerging nations (Napwanya & Chinyamurindi, 2021; Asieba, & Nmadu, 2018). The connections to poverty, however, remain debatable. The literature on this subject can be grouped into two categories of thinking regarding the relationship between poverty and informality: the pessimistic group and the optimistic group. According to the pessimistic viewpoint, the informal sector comprises of marginal and subsistence activities, with poor production and remuneration for its participants. Informal workers have no social protection and very bad working conditions (Canelas & Niño-Zarazúa. 2022; Dell'Anno, 2022; Onwo & Ohazulike, 2021). As a result, the informal sector exacerbates poverty and has a negative impact on poverty reduction. Furthermore, Navarrete-Hernández, Alford and Toro (2023) finds that the high prevalence of informal employment in developing nations generates poverty traps for workers and limits developing countries' ability to gain from trade. While businesses in the informal sector are typically too small to foster innovation and value creation or to take advantage of economies of scale, Folawewo and Orija, (2020) explained that informal employment makes it difficult for people to acquire formal generic skills. Furthermore, Davida, *et al.*, (2023) discovered that while the informal sector contributes to social stability in an economy that has undergone a socialist transition, it is unable to reduce poverty. In the second perspective, there is a positive correlation between informality and poverty reduction, and not all individuals employed in the informal sector are impoverished. Numerous empirical researches lend credence to this hopeful view. As acknowledged by Folawewo and Orija, (2020), most informal participants earn little money and reside below or near the poverty line but poverty would be far more severe without the informal sector. The confirmation from the view of several researchers have found a stronger link between poverty and the informal sector (Sharma & Adhikari, 2020; Delbiso et al., 2018; Aissata, , *et al.*, 2017; Barros & Chivangue, 2017). Onwo and Ohazulike (2021) stated that the average income in the informal sector is less than that in the formal sector. This is so because the informal sector is made up of various businesses that produce goods or services with the main objective of creating jobs



and revenue for the people who work directly in it. Thus, the following null hypotheses emerged:

H_{0A}: Informal sector size is not significantly related to rural poverty reduction

H_{0B}: Informal sector activities is not significantly related to rural income

H_{0C}: Informal sector activities is not significantly related to rural poverty reduction

H_{0D}: Government policies and programs on Informal sector development is not significantly related to rural poverty reduction in Lagos State

Conceptual Review

The informal sector, which includes unpaid labour in family businesses, casual wage jobs, home-based labor or service providers, and street vending, is typically the only way for the impoverished to survive in slums, as well as for those from rural areas who are exposed to natural disasters or severe urbanization (Mahadea & Zogli, 2018). This is especially common during periods of slower economic growth and recession, which lowers the national productivity (Gross Domestic Product (GDP)). As a result, income inequality is caused by the growing output gap (Tabash, , et al., 2024; Aiyar & Ebeke, 2019; Pettinger, 2017). Due to the formal sector's and national/local governments' inability to handle the abrupt increase in migration, people turn to the informal economy for economic support and survival (Etim & Daramola, 2023). Thus, informal employment becomes a feasible choice in situations with high rates of underemployment, unemployment, low capital inflows, a lack of social safety or benefits, and low human capital development. Although skilled people may be hired by employers in informal manufacturing to operate smaller, more lucrative informal firms as stated by Skinner, (2020), were noted to be situated for most part as the informal employment remains the sole feasible choice for these workers.

Conceptualization of poverty considers the poor as individuals whose standard of living falls below the poverty line; that is identified by international bodies such as International Labour Organization. This is birthed on the need to distinguishes the poor from the rich, as determined by income or consumption (Adaramola & Obalende, 2013). Eggon, and Adelowo (2021) argued that the underprivileged make less than one US dollar (1\$) a day, which has an impact on their ability to pay for necessities. However, Eggon, and Adelowo (2021) clarified that poverty constitutes a state of extreme deprivation in society as well as a low level of living. Eigbiremolen (2022) expressed poverty as a condition of need, indigence, and lack of means of sustenance, but Francis, Eggon, and Adelowo (2021) stated that poverty is defined as not having enough money or resources to meet one's basic needs. Ijaiya et al. (2015), posited that the primary causes of poverty in Nigeria are limited access to work opportunities, the lack of physical assets like land and capital, as well as the poor's limited ability to obtain credit, even on a small scale; In addition to this reason were the inability to support rural development in underdeveloped areas and lack of markets where the poor can sell goods and services, low human capital endowment, depletion of natural resources resulting in environmental degradation, particularly in rural areas, and most acclaimed from many researchers, the occurrence of decreased productivity. Inadequate access to aid for marginalised individuals, those experiencing temporary poverty, and those who are not involved are also factors (Sabates-Wheeler & Barker, 2024; Antonopolis, 2023; Saaida & Saaidah, 2023; Thambiah & Loh, 2023; Huang et al., 2020).



Research Design and Methodology

Discuss the proposed research design and methodology.

This study adopted a quantitative research design to investigate the influence of public administrator's initiative with respect to informal sector development and reduction of poverty incidence in the rural area in Lagos State. Grounded in institutional theory, this study employed positivism as a research philosophy since the study was confined to the use of acquired data and an objective method was used to analyze the data collected. This study purposely samples 384 small business owners in Epe and Ikorodu areas of Lagos state using questionnaires. The districts of Epe and Ikorodu in Lagos State Nigeria stand out as rapidly expanding areas heavily dependent on informal sector activities. Local economies in these regions run on fishing, agriculture, small-scale trade, and artisanal work, which act as fundamental components of their economic activity. Even if these areas have economic promises, large-scale poverty persists because of poor infrastructure, circumstances of the volatile market, and restricted access to formal employment possibilities. The informal sector significantly contributes to the reduction of poverty in these areas by offering opportunities to people who do not have the appropriate educational history to pursue official jobs. Sustainable economic growth remains unattainable due to poor financial inclusion and unstable income streams combined with inadequate government support. The daily earnings people receive from informal businesses sustain many residents but expose them to risks from economic fluctuations. To develop effective public policies that enhance living standards, it is necessary to analyze poverty alongside the informal sector within Epe and Ikorodu. By researching the relationship between informal employment, household income patterns, and economic survival methods, policymakers may address structural poverty. More inclusive economic planning is made possible by the analysis of government initiatives like microfinance and skill-building training for local communities, which supports long-term growth in Lagos State.

Population and Sample

This section should indicate the population, sampling technique and size selected for the study. These decisions should be justified.

Research Instrument

The instrument used for field data collection in conducting research must match the study's purpose. For this analysis, the methods used to collect data were a collection of questionnaires. Questionnaires are of different types including scale of ratings, open-ended questions, dichotomous or yes or no questions (Dhaval, *et al.*, 2023). The close-ended questions, which include the rating scales, dichotomous and multiple choice is advantageous in the sense that, therefore, it is easier to give out time savings to many respondents. Therefore, the data are scored more accurately and critically, making it easier to score, tabulate and interpret data. (Ochepa, Sule, , *et al.*, 2017). The data required for this research was collected using closed-ended questions. It will involve the selected respondents ticking the correct choice for the questions asked using a Likert scale of 1-5 (Sharma, 2024; Surur, , *et al.*, 2022; Architha & Aithal, 2020)

Measurement of Variables



Informal Sector Size (ISS): measure with the number of employees in the sampled small businesses.

Rural Poverty (RPR): The percentage of employee's monthly income spend per day on food, housing, and health was used to measure rural poverty. Those less than \$1.90 per day were coded as poor (1) and otherwise coded not poor (0) (World Bank extreme poverty line)

Informal Sector Activities (ISA): This study used estimated monthly business income and age of the business to measure informal sector activities

Rural Income (RIY): Average daily income of the employees

Government Policies and Programs on Informal sector development (gpp): owners of small business awareness and accessibility of government initiatives geared toward small businesses in the state

Data Collection

The selection of respondents or organizations from a population to be used for a study can be done using different approaches, these approaches are the sampling techniques. The numerous sampling techniques include, among others, completely random, systematic, easy, purposive, and snowballing (2019). The sampling technique used in the conduct of the study is Simple Random Sampling, which involves randomly selecting the sample without bias.

This study employed Cochran (1977) formula for calculating sample size with infinite population. Cochran (1977) developed a formula to calculate a representative sample from infinite population which is;

$$n_0 = \frac{z^2 pq}{e^2}$$

where, n_0 = sample size, z = critical value of desired confidence level, p = estimated proportion of an attribute that is present in the population, $q = 1 - p$ and e is the desired level of precision.

$$P = 0.5; q = 1 - 0.5 = 0.5; e = 0.05 \text{ (95\% confidence level)}$$

Therefore,

$$n_0 = \frac{(1.96)^2 (0.5)(0.5)}{(0.05)^2}$$

$$n_0 = 384.16$$

$$n_0 \approx 384$$

The scale of business that this study is aimed at investigating, are microscale enterprises operating in the study area for over 2 years. The rationale for choosing purposive sampling method is that, most of these businesses are hardly registered in a formalized system, a very little at the medium scale have some form of registration with corporate affairs commission. This made it nearly impossible at this stage of research, to source the exact number of small business within Epe and Ikorodu area of Lagos State. The selection criteria



for the targeted respondents include small businesses with between 1 to 3 employees were and being in operation for more than 2 years were sampled.

Ethical Considerations

The ethical standpoint of this study was considered throughout the whole data collection process, with emphasis being placed on the privacy and informed consent of the participant, as recommended by Bryman & Bell (2011). Respondents were given the option to withdraw their consent at any time up until a pre-established date, after which the data had been fully processed and anonymised and thus would have been impossible to retrieve. This information was captured on the distrusted questionnaire. The research was designed to be entirely safe for all parties involved and data was kept securely mainly for research purpose.

Results and Findings

This employed quantitative analytical techniques to analysis data collected through structured questionnaires administered to the 350 small business owners in Epe and Ikorodu area of Lagos state. Copies of questionnaire were administered and retrieved after several weeks of follow up. The copies of questionnaire were later coded and inputted carefully one after the other into the SPSS version 22. Data inputted into the software were first presented using tables of frequency and descriptive statistics. The descriptive statistic table included the mean and frequencies of all items in the questionnaire. Also, quantitative statistical test such as ANOVA and t-test were used to test the validity or otherwise of the four hypotheses generated from the research questions

Descriptive Analysis

This study randomly distributed questionnaires to 384 small business owners in the Epe and Ikorodu regions of Lagos, Nigeria, during a four-week period, after which 350 properly completed questionnaires were collected for examination after administering 384 copies of questionnaires-192 copies in each study area. The correctly filled surveys constitute 91 percent of the total copies of questionnaires distributed. The frequency distribution of respondents presented in table 1 revealed that 69 percent of them are male and 31 percent female. This indicates that most of the owners of small business in the informal sector are male. Further breakdown of the respondents shows that young people aged below 31 years (54%) are more in the informal sector. In fact, most of the respondents are never married (66%). This stressed the preference for informal sector by younger generations. Likewise, 49 percent of the respondents have no dependent, 48 percent have 1-4 dependents, and 3 percent have 5-8 dependents. On highest qualification, 37 percent of the respondents hold Bachelor of Science degree while 20 percent hold master's degree, 27 percent holds Higher National Diploma and 16 Ordinary National Diploma. Table 1 also revealed that 44 percent of the respondents have being running their business for less than 5 years, 37 percent for between 5 to 8 years, 11 percent between 8 to 12 years while 8 percent possessed 13 years and above.

Further examination of the descriptive statistics revealed that the high male presence (69%) suggests that female entrepreneurs require more assistance. Thus, more gender friendly and youth initiatives are required, since 54% of respondents were young and 66% were unmarried. About half of the respondents reported no dependents, which has an impact on investing and saving. Due to the wide range of educational backgrounds, from degree holders to those with



less schooling, there is potential for educational instruction specifically designed for this demographic. In addition, 44% of them have less than five years of company experience, and in order to improve poverty recovery or guarantee reasonable business continuity, they will either require financial assistance or market access.

Table 1: Respondent's Bio-Data

Respondents' characteristics	Frequency	Percentage (n = 350) %
Gender Distribution		
Male	240	69
Female	110	31
Age Range (years)		
18-25	58	17
26-30	132	37
31-35	70	20
36-40	43	12
41-45	23	7
46-50	18	5
50 and above	6	2
Marital Status		
Single	227	66
Married	103	29
Divorced	5	1
Separated	15	4
Number of Dependents		
None	170	49
1-4	169	48
5-8	11	3
9-12	-	-
13 and above	-	-
Highest Educational Qualification		
SSCE	-	-
OND	55	16



HND	95	27
BSc	131	37
Master's degree	69	20
Age of the business (years)		
1-4	153	44
5-8	129	37
8-12	38	11
13 and above	30	8

Source: Fieldwork (2025)

Analysis of Variance (ANOVA)

This study utilized Analysis of Variance (ANOVA) technique to test the validity of otherwise of all the four hypotheses. The four hypotheses are stated as follows;

H_{0A}: Informal sector size is not significantly related to rural poverty reduction

H_{0B}: Informal sector activities is not significantly related to rural income

H_{0C}: Informal sector activities is not significantly related to rural poverty reduction

H_{0D}: Government policies and programs on Informal sector development is not significantly related to rural poverty reduction in Lagos State

Table 2 presents the model summary which indicated the predictive power of the model. Model summary table presents the explanatory power of the independent variables in the model. The adjusted R square of the informal sector size (ISS) model indicated that informal sector size (ISS) explained 27 percent changes in rural poverty reduction (RPR) in Lagos state while informal sector activities (ISA) explained 17 percent changes in rural sector income (RIY) in the state. Furthermore, informal sector activities explained 39.4 percent changes in rural poverty reduction in Lagos while government policies and program (GPP) on informal sector development explained 13 percent changes in rural poverty reduction in the state.

Table 2: Model Summary

Models	R square	Adjusted R square
ISS >> RPR	0.292	0.272
ISA >> RIY	0.202	0.174
ISA >> RPR	0.408	0.394
GPP >> RPR	0.134	0.130

Source: Fieldwork (2025)



Table 3 presents the test for the overall significance of the models employed which revealed that all the four hypotheses model were statistically significant at 5 percent significance level. Specifically, Table 4 present the estimated coefficients of the parameters in the four models. 1 unit change in the size of the informal sector in Epe and Ikorodu area of Lagos state can induce 0.212 units inverse change in rural poverty reduction while 1 unit change in the informal sector activities in the State can induce 0.299 direct change in rural sector income. Also, 1 unit change in informal sector activities in the state can induce 0.233 units inverse changes on rural poverty while 1 unit change in public administrators' policies and program on informal sector development can induce 0.177-unit direct change in rural poverty reduction in the state.

Table 3: ANOVA

Models	F	Significance
ISS >> RPR	14.731	0.00
ISA >> RIY	10.327	0.00
ISA >> RPR	33.787	0.02
GPP >> RPR	7.344	0.01

Source: Fieldwork (2025)

Table 4: Coefficient

Models	Parameter		Significance
	Coefficient	T	
ISS >> RPR	- 0.212	6.846	0.01
ISA >> RIY	0.299.	3.123	0.00
ISA >> RPR	- 0.233	6.712	0.00
GPP >> RPR	0.177	2.714	0.03

Source: Fieldwork (2025)

Discussion of Findings

This study tested four hypotheses to assess the direction and significance of link between informal sector development (informal sector size, informal sector activities and government policies and programs on informal sector) and rural poverty reduction in Lagos state. The results of the first hypothesis indicated that there is direct and significant relationship between informal sector size and rural poverty. Also, the second hypothesis tested revealed that informal sector activities exert direct and statistically significant influence on rural income in the study area. These findings are consistent with the study by Cichello and Rogan (2023) where they observed that Informal regular wage occupations and domestic work have a greater influence on poverty severity per job compared to formal employment. Similarly, Wachukwu and Charles (2024) and ILO (2023) affirmed that without informal income, household poverty would grow steadily overtime. Thus, they asserted that increasing the informal sector decreases the likelihood of poverty.



Furthermore, the results of the third hypothesis revealed that there is direct and statistically significant relationship between informal sector activities and rural poverty at 5 percent significance level. Similarly, Peprah, *et al.*, (2019) also found that informal sector activities influence rural poverty in among women in Kumasi metropolis, Ghana.

The result of the fourth hypothesis affirm that the government policies and programs on informal sector development exert significantly significant direct effect on rural poverty. This finding affirmed assertion by Cichello and Rogan (2020) that informal sector has a different impact on poverty characteristics including head count, poverty gap, and severity compared to the formal sector.

Managerial Implications

The findings of this study offer important managerial and policy-relevant insights for poverty reduction strategies in Lagos State. The significant relationship between informal sector size and rural poverty reduction indicates that development managers and policymakers should recognise the informal sector as a productive and enduring component of the rural economy rather than a transitional or residual one. Managerial efforts should therefore prioritise integrating informal economic activities into rural development frameworks through improved access to basic infrastructure, local markets, and productive assets.

The significant influence of informal sector activities on rural income highlights the need for programme managers to focus on enhancing productivity and income quality within the informal sector. Practical interventions such as targeted skills development, access to microcredit, and business support services can strengthen the income-generating capacity of informal enterprises. These measures are particularly relevant in rural contexts where formal employment opportunities remain limited and informal income serves as a key buffer against poverty.

Furthermore, the direct effect of informal sector activities on rural poverty reduction suggests that poverty-focused programmes should deliberately target informal workers, especially women and youth who are disproportionately represented in the sector. Managers of social and economic programmes should adopt inclusive approaches that lower entry barriers, support enterprise sustainability, and reduce vulnerability to income shocks.

Finally, the significant impact of government policies and programmes on informal sector development underscores the importance of supportive and well-coordinated policy implementation. Rather than restrictive regulatory approaches, government agencies should adopt enabling policies such as simplified registration procedures, inclusion of informal workers in social protection schemes, and access to public services. Collectively, these findings recommend a shift towards managing informal sector development as a strategic policy instrument for sustainable rural poverty reduction, consistent with the policy orientations advocated by institutions such as the ILO and development-focused journals.

Conclusions and Future Research

This study concluded that for many people, the informal sector has been a source of both voluntary and involuntary work and income, regardless of the causes for its emergence. The marginalized community has used it as a coping mechanism to combat poverty and poor income.



Government measures, such as microcredit, business training, and infrastructure development, can boost small business size which can facilitate reduction in rural poverty. Also, the government need to integrate informal businesses into formal value chains through partnerships with larger firms which can boost income generating capacity.

Furthermore, in order, to enhance small business activities in the rural area, the government should simplify taxation policies which will encourage business growth and long-term economic stability. This would increase the informal sector activities towards reducing the prevalence of poverty.

Meanwhile the shift from the informal to the formal sector which is the recommendation of many empirical studies has not occurred, hence, this study recommends that active and functional grassroot participation by the state and local governments in the form of education, skill development, and support is required. This will foster grassroot acceptance and alignment with public administration policies on informal sector development.



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Indigenous Knowledge and Cultural Governance in Environmental Policy: Restoring the Ancestral Ethic of Stewardship

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Abstract

The scholarly discourse surrounding environmental governance has undergone a radical shift from the colonial exclusion of indigenous populations to the contemporary recognition of Indigenous Knowledge Systems (IKS) as indispensable for ecological resilience. This paper examines the historical marginalization of these systems within Uganda, specifically through the "fortress conservation" model—and argues for a transition toward a relational model of reciprocity. Drawing on a tri-sectoral analysis of academic literature, Ugandan legislative frameworks (notably the National Environment Act 2019), and indigenous community records, the study delineates the "experiential epistemology" of the Batwa, Baganda, and Karamojong peoples. The findings reveal that indigenous structures, such as the Baganda totemic system and Karamojong migratory grazing patterns, often outperform top-down state interventions in securing biodiversity and climate resilience. The research concludes that true ecological sustainability requires moving beyond "tokenistic inclusion" toward pluriversal governance. This necessitates the legal validation of spiritual and oral traditions, the protection of indigenous intellectual property, and the redistribution of authority to local custodian clans. By operationalizing an ancestral ethic of stewardship, Uganda provides a transformative blueprint for bridging the gap between Western scientific paradigms and the biocultural wisdom necessary for a sustainable future.

Keywords: *Indigenous Knowledge Systems (IKS), Ancestral Ethic of Stewardship, Ecological Knowledge, Totemic Restrictions.*

1. Introduction

1.1. Background

The global environmental crisis, characterized by unprecedented biodiversity loss, systemic climate instability, and the degradation of vital ecosystems, has exposed the fundamental limitations of contemporary resource management paradigms. For decades, the dominant approach to environmental governance has been rooted in a Western scientific tradition that prioritizes "fortress conservation", the separation of humans from nature, and a techno-rationalist view of the environment as a set of commodities to be managed (Brockington, D. 2002). However, as global ecological thresholds are breached, there is a burgeoning realization that purely technical solutions are insufficient. This paper explores a transformative alternative: the integration of Indigenous Knowledge Systems (IKS) and cultural governance as the foundation for a restored "ancestral ethic of stewardship."

Indigenous knowledge is not a static relic of the past; it is a dynamic, "experiential epistemology" deeply embedded in the cultural practices, spiritual beliefs, and social textures of communities that have co-evolved with their landscapes for millennia (Vidal, T., et al. 2024). In the context of Uganda, these systems offer robust frameworks for environmental



management that often surpass the efficacy of top-down, Western-centric models. From the sacred groves of the Baganda to the rangeland management of the Karamojong and the forest-dwelling wisdom of the Batwa, Ugandan indigenous communities have historically operated under a relational model of reciprocity. In this worldview, humans are not external masters of the earth but are an integral part of a living, sentient ecosystem. (Mugisha, A. R. 2021)

This paper posits that the formal incorporation of indigenous knowledge into environmental policy is not merely an act of cultural preservation or social justice; it is a pragmatic necessity for achieving long-term sustainability. By leveraging generations of accumulated ecological wisdom and community-based conservation strategies (Ijatuyi et al., 2025), policymakers can move beyond the "anthropocentric model of exploitation" and adopt a "pluriversal" approach to governance. (Kabeer, N. 2024)

Such an approach legitimizes diverse ways of knowing and recognizes that the health of the human community is inextricably linked to the health of the land.

The central argument of this work is that the restoration of an ancestral ethic of stewardship, codified through modern legal instruments like Uganda's National Environment Act of 2019, can provide the resilience needed to face contemporary ecological challenges. This paper will analyze how these cultural governance structures function, examine the legal shift toward the "Rights of Nature" in Uganda, and propose a framework for a biocultural policy that honors the rights of both human and "other-than-human" actors (Ijatuyi, O. O., et al. 2025). By shifting the focus from "resource management" to "relational care," we can forge a path toward a more sustainable and equitable ecological future. (Ijatuyi et al., 2025).

1.2. Problem Statement

Despite the efficacy of these systems, the historical marginalization of indigenous ecological knowledge within mainstream environmental governance remains a critical issue. The colonial legacy in Uganda established a model of "fortress conservation" that viewed indigenous land use as a direct threat to the Western ideal of "pristine" wilderness (Brockington, D. 2002). This led to the physical and conceptual removal of local populations from their ancestral lands. The "techno-rationalist" approach dismissed traditional ecological wisdom as unscientific, replacing ethical and relational contexts with an "anthropocentric model of exploitation."

The problem persists today where top-down state interventions often fail to secure biodiversity, leading to the alienation of communities from their life-support systems. While there is a shift in discourse, the challenge remains to move beyond "tokenistic inclusion" where indigenous voices are merely consulted, to a pragmatic integration of IKS into formal policy. The failure to fully operationalize this "ancestral ethic of stewardship" threatens both the cultural survival of these communities and the ecological resilience of the region.

1.3. Research Objectives

This paper aims to bridge the gap between Western scientific paradigms and indigenous biocultural wisdom. The specific objectives of this study are:

1. To analyze how indigenous cultural governance structures, specifically among the Batwa, Baganda, and Karamojong, function as mechanisms for ecological stewardship.



2. To examine the historical marginalization of cultural systems and the contemporary legal shift toward the "Rights of Nature" in Uganda.
3. To propose a framework for a biocultural policy that legitimizes diverse ways of knowing and operationalization of ancestral ethics of stewardship.

2. Literature Review

2.1. The Theoretical Framework Underpinning the Study

The transition toward more effective environmental policy in the Global South requires a departure from monolithic scientific management toward what scholars define as a "*pluralistic approach*." This theoretical framework recognizes that the challenges of the Anthropocene cannot be solved by a single knowledge system; rather, integrating diverse knowledge systems, scientific, local, and indigenous, leads to more comprehensive biodiversity governance and resilient ecosystem management strategies.

The Pluriversal vs. The Universal

At the heart of this framework is the advocacy for a "pluriversal" approach to governance. (Kabeer, N. 2024) While traditional Western policy often seeks "universal" truths, laws and conservation methods intended to apply everywhere, pluriversality acknowledges a world where many worlds fit. This model goes beyond "tokenistic inclusion," where indigenous voices are merely "consulted" to provide a cultural veneer to pre-decided scientific agendas. Instead, pluriversal governance seeks to fundamentally legitimize diverse ways of knowing and relating to the natural world, granting indigenous experiential epistemology the same legal and intellectual weight as quantitative data. (Vidal, T., et al. 2024)

Biocultural Principles and the Rights of Nature

Central to this integration is the adoption of "biocultural principles." (Ijatuyi, O. O., et al. 2025). This theory posits that biological diversity and cultural diversity are mutually reinforcing; the loss of indigenous languages and traditions often precedes the degradation of the local environment. By honoring the specific rights of indigenous communities, such as those of the Bagungu or Batwa in Uganda, policy moves from a "resource management" mindset to a "relational model of reciprocity." This framework is increasingly supported by the legal recognition of the *Rights of Nature*, which views ecosystems as sentient entities with inherent rights to exist and regenerate, rather than as mere "externalities" or commodities.

Addressing the Power Asymmetry

To move from theoretical advocacy to tangible policy implementation, scholarship increasingly emphasizes the urgent need to dismantle the historical power imbalances that continue to subordinate Indigenous Knowledge Systems (IKS) to Western scientific paradigms. A pluralistic framework is only effective if it moves beyond the superficial acknowledgment of culture and actively restructures the legal and institutional hierarchies that govern natural resources. In the Ugandan context, this transition toward an "ancestral ethic of stewardship" requires a rigorous focus on three pillars of structural reform: the protection of intellectual property, the decentralization of authority, and the achievement of epistemological justice.



The first essential pillar is the *Protection of Indigenous Intellectual Property*. For decades, indigenous communities have faced the threat of "biopiracy," where traditional botanical and ecological knowledge is extracted by external actors, often multinational corporations or foreign research institutions, and patented without consent or benefit-sharing. To address this power asymmetry, environmental policy must ensure that "traditional botanical and ecological knowledge is not extracted and patented by external actors" (Ijatuyi et al., 2025). This requires the development of *sui generis* legal systems that recognize the collective ownership of knowledge, ensuring that the communities who have curated these biological secrets for millennia remain the primary beneficiaries of their application.

Furthermore, true pluralism necessitates a radical shift toward *Decentralized Authority*. Modern environmental governance in Uganda has traditionally been characterized by central bureaucracies, such as the National Environment Management Authority (NEMA) or the Uganda Wildlife Authority (UWA), which often operate with a top-down mandate. Addressing the power gap involves "shifting decision-making power from central bureaucracies to local 'custodian clans' who hold the ancestral mandate of stewardship." (Government of Uganda 2019) By empowering these traditional leaders, such as the clan heads of the Bagungu or the elders of the Karamojong, policy transitions from a model of state policing to one of community-led care. This decentralization recognizes that those closest to the land possess the most acute "place-based" virtue and are best positioned to enforce sustainable management through social rather than punitive pressure. (Malapane, A., et al. 2022)

Finally, the most profound shift required is the pursuit of *Epistemological Justice*. This concept involves "validating spiritual taboos and oral histories as credible forms of 'long-term observational data' essential for climate adaptation." In current scientific discourse, indigenous claims are often dismissed if they cannot be replicated in a laboratory. Epistemological justice demands that we recognize spiritual regulations, such as the protection of sacred groves or the observation of totemic restrictions, as valid ecological data points (Mugisha, A. R. 2021). By treating oral traditions not as myths but as centuries of longitudinal environmental records, policymakers can bridge the gap between "Western techno-rationalism" and "indigenous experiential epistemology." (Vidal, T., et al. 2024)

Ultimately, addressing these power asymmetries is the only way to ensure that the "restoration of the ancestral ethic" is more than a rhetorical gesture. It requires a fundamental reordering of how knowledge is protected, how authority is distributed, and how truth is defined. By securing the rights and legitimizing the wisdom of Ugandan indigenous communities, environmental policy can finally achieve the "relational model of reciprocity" necessary to confront the global ecological crisis.

By adopting these biocultural and pluralistic frameworks, Ugandan environmental policy can restore the "*ancestral ethic of stewardship*," creating a governance model that is not only ecologically sound but socially just and culturally resonant. (Ijatuyi, O. O., et al. 2025).

2.2. A Conceptual Literature Review

This section reviews the mechanisms of traditional ecological stewardship defined in the literature, characterizing them as an "architecture of ancestral care."

The efficacy of Indigenous Knowledge Systems (IKS) in Uganda and the broader African context is rooted in what scholars define as an "experiential epistemology". Unlike the



reductionist nature of Western scientific paradigms, which often attempt to isolate ecological variables from their social contexts, indigenous wisdom operates on the fundamental premise that "humans are an integral part of the ecosystem, not separate from it". This holistic perspective manifests through three primary mechanisms: place-based stewardship, cultural regulation via spiritual taboos, and adaptive observational data.

The Virtue of Place-Based Stewardship

At the heart of indigenous conservation is the concept of "place-based stewardship." This mechanism goes beyond simple resource management to foster a "unique environmental virtue where human well-being is inextricably linked to the health of the ecosystem". In regions like the Bwindi Impenetrable Forest or the Lake Victoria basin, stewardship is not a professionalized duty but a communal identity. Research suggests that this localized "power of place" creates an agency for wildlife and habitat protection that top-down state policies often fail to replicate. By grounding conservation in the specific history and spiritual geography of a location, communities develop a relational model of reciprocity rather than a model of exploitation.

Cultural Regulation and the Codification of Taboos

In the context of Ugandan environmental governance, the restoration of an ancestral ethic of stewardship relies heavily on localized cultural mechanisms that ensure biological preservation through social and spiritual obligation. These mechanisms, often categorized under cultural regulation, provide a sophisticated framework for biodiversity management that functions independently of state policing.

Within many Ugandan societies, such as the Baganda and various groups in the Albertine region, *Totemic Restrictions* serve as a vital biological safeguard. Under this system, specific clans are strictly prohibited from consuming, hunting, or harming their representative totem, be it a particular animal, insect, bird, or plant. This cultural prohibition effectively creates a distributed, community-led network of biodiversity protection, ensuring that various species remain protected across vast geographical areas due to the social identity and ancestral allegiance of the human population. (Mugisha, A. R. 2021)

Furthermore, the designation of Sacred Natural Sites provides a physical anchor for this stewardship. Areas such as ancestral groves, specific hills, or ancient water sources are viewed as the dwelling places of spirits or ancestors, rendering them "refugia" where human interference is largely forbidden. These sites often host rare or endemic species that might otherwise face extinction in more heavily trafficked areas. Unlike modern national parks that may require heavy surveillance, these sacred sites are self-policing through the mechanism of Spiritual Accountability. Because these regulations are viewed as spiritual mandates rather than mere bureaucratic rules, community compliance is often significantly higher than that of state-imposed laws. In this worldview, ecological degradation is not merely a legal infraction but a profound "breach of social and ancestral harmony" that could bring misfortune upon the community.

By integrating these traditional mechanisms into contemporary policy, environmental governance can move toward a more "pluriversal" approach. (Kabeer, N. 2024) This shift recognizes that the most effective way to protect Uganda's natural heritage is to honor the



"experiential epistemology" of its people, where the health of the land and the spiritual well-being of the community are inextricably linked.

Adaptive Solutions and Ecosystem-Based Adaptation

Finally, in the pursuit of global environmental resilience, the integration of Indigenous Knowledge Systems (IKS) offers a sophisticated framework for Ecosystem-Based Adaptation (EbA) (Chanza, N., & Musakwa, W. 2021). This mechanism allows IKS to provide "precise and straightforward solutions to modern ecological crises," most notably climate change. Unlike static historical records, traditional practices function as "active, experiential epistemologies". They are built upon "long-term observational data inherent in traditional practices," which facilitate a nuanced understanding of environmental shifts, such as subtle changes in soil moisture, micro-climates, and phenology, that purely quantitative, macro-level scientific models might overlook.

The adaptive capacity of Ugandan Indigenous Knowledge Systems (IKS) is perhaps most evident in the practical application of ancestral wisdom to the management of scarce resources. By utilizing "active, experiential epistemologies," these communities have developed sophisticated strategies for ecosystem-based adaptation that ensure long-term resilience. These adaptations are not merely theoretical but are grounded in "place-based stewardship" where human well-being is "inextricably linked to the health of the ecosystem".

One of the most critical manifestations of this knowledge is Traditional Water Harvesting. In Uganda's more arid regions, indigenous communities employ a blend of "ancestral engineering and seasonal knowledge" to navigate periods of extreme water scarcity. These systems are designed to ensure communal survival while maintaining hydrological integrity, carefully managing extraction to avoid "depleting the water table". (Vidal, T., et al. 2024) Such practices reflect an "experiential epistemology" where the community acts as a primary steward of the watershed, balancing human needs with the vital cycles of the earth.

In the rangelands, *Migratory Grazing Patterns* serve as a vital mechanism for maintaining "ecological balance". Pastoralist groups, such as the Karamojong, do not move randomly; rather, they follow "migratory routes informed by generations of climate observation". By rotating grazing areas based on precise indicators of vegetation health and rainfall patterns, they effectively "prevent overgrazing". This method of "place-based stewardship" ensures that the rangelands can regenerate, demonstrating a relational model of reciprocity that stands in contrast to the destructive nature of sedentary, industrial livestock management.

Furthermore, the Forest Intelligence possessed by communities like the Batwa illustrates a deep "experiential understanding of forest succession and wildlife behavior". The Batwa do not simply extract resources; they "adapt their harvesting cycles to changing seasonal patterns," ensuring that their presence supports rather than diminishes the forest's health. This reflects a "harmonious coexistence with nature," where human activity is synchronized with the natural pulses of the ecosystem.

Ultimately, these practices demonstrate that indigenous knowledge is a "vital component of sustainable resource management" (Malapane, A., et al. 2022). By restoring this "ancestral ethic of stewardship," environmental policy can move away from an "anthropocentric model of exploitation" and toward a "pluriversal" approach that honors the rights of both human and "other-than-human actors". (Kabeer, N. 2024)



2.3. An Empirical Literature Review

The empirical literature highlights the historical context and the measurable impact of colonial marginalization on these systems.

Historical Marginalization and the Colonial Legacy

The historical marginalization of indigenous ecological knowledge (IKS) within mainstream environmental governance is not merely an oversight of the past but a documented consequence of structural erasure. During the colonial era in regions like Uganda, environmental management was defined by "fortress conservation", a model that viewed indigenous land use as a direct threat to the Western ideal of "pristine" wilderness. This paradigm necessitated the physical and conceptual removal of local populations from their ancestral lands to make way for state-controlled reserves.

The colonial legacy in Uganda was characterized by a systematic dismantling of indigenous environmental governance through three primary vectors: epistemological displacement, the criminalization of traditional practices, and state-centric resource extraction.

The first vector, *Epistemological Displacement*, involved a fundamental shift in how environmental knowledge was valued. Traditional ecological wisdom, refined over millennia, was dismissed as "unscientific or anecdotal" by colonial administrators. It was replaced by a rigid "techno-rationalist" approach, a Western scientific paradigm that intentionally "ignored the spiritual and cultural dimensions of ecology". (Vidal, T., et al. 2024) This displacement stripped environmental management of its ethical and relational context, viewing nature merely as a collection of variables to be manipulated rather than a living system of which humans are an "integral part".

This intellectual erasure paved the way for the *Criminalization of Tradition*. Practices that were once central to maintaining ecological balance were redefined through the lens of colonial law as illicit activities. For example, the "controlled burning of rangelands by the Karamojong" and the "sustainable forest harvesting of the Batwa" were reclassified as "poaching" or "encroachment". This legal shift caused the profound "alienation of communities from their life-support systems," transforming indigenous stewards into legal trespassers on their own ancestral lands. (Malapane, A., et al. 2022)

Finally, these shifts were consolidated through *State-Centric Extraction*. Under colonial rule, conservation was frequently utilized as a "facade for resource extraction". By designating vast areas as "Crown Lands," the colonial state assumed total ownership to "manage timber and minerals" for export and profit. This process effectively dismantled the "ancestral ethic of stewardship" that had successfully maintained "ecological balance for centuries". By centralizing power and prioritizing economic development over ecological integrity, the state replaced a "relational model of reciprocity" with an "anthropocentric model of exploitation," the repercussions of which continue to challenge modern biodiversity governance.

However, recent academic shifts have begun to challenge these anthropocentric foundations. Emerging scholarship now recognizes IKS as a "vital component of sustainable resource management" rather than a historical relic. (Malapane, A., et al. 2022) The failure of many top-down, state-led conservation initiatives in Uganda suggests that modern policy must move beyond this colonial legacy toward a "pluriversal" approach. (Kabeer, N. 2024) This requires



addressing historical power imbalances and adopting biocultural principles that honor the rights of indigenous communities to manage their lands through their own experiential epistemologies. (Ijatuyi, O. O., et al. 2025).

2.4 Uganda's Position in Global Policy Discourse: A Vanguard for the Rights of Nature

In the specific context of Uganda, contemporary literature highlights a significant legal and ontological evolution that places the nation at the forefront of global environmental discourse. While much of the international community still struggles with the "tokenistic inclusion" of Indigenous voices, Uganda's transition from an anthropocentric model of exploitation to a relational model of reciprocity is exemplified by the landmark National Environment Act (NEA) 2019. (Government of Uganda 2019)

Scholars argue that by restoring this "ancestral ethic of stewardship" through formal legislation, Uganda is successfully bridging the gap between rigid Western scientific frameworks and the profound ecological wisdom of its Indigenous peoples. The significance of Uganda's position in the global discourse is characterized by three transformative shifts:

I. Codifying the Rights of Nature

Uganda is among the first nations in Africa to legally recognize that "*Nature has the right to exist, persist, maintain and regenerate its vital cycles*" (Section 4, NEA 2019). This is not merely a legal technicality; it is a legislative mirror of the Indigenous worldview, specifically that of the Bagungu and Batwa, which views the environment as a sentient entity rather than a resource to be harvested. This move signals a departure from the "techno-rationalist" approach of the colonial era and aligns state law with the ancestral belief in human-nature interdependence.

II. Institutionalizing Biocultural Pluralism

The Ugandan discourse suggests that "pluralistic governance" is the only viable path for sustainable biodiversity management. (Malapane, A., et al. 2022) By integrating Indigenous Knowledge Systems (IKS) into Environmental and Social Impact Assessments (ESIA), Uganda is creating a precedent for how "experiential epistemology" can coexist with scientific data. The literature emphasizes that this pluralism ensures a sustainable future for both "human and other-than-human actors" by validating local taboos and customary laws as legitimate regulatory tools.

III. A Model for Global Climate Resilience

Global policy experts are increasingly looking toward Uganda's localized adaptation strategies, such as the Karamojong rangeland management and community-led wetland restoration, as blueprints for Ecosystem-Based Adaptation (EbA). Uganda's position demonstrates that "place-based stewardship" fosters an agency for wildlife and habitat protection that top-down international treaties often fail to inspire. (Chanza, N., & Musakwa, W. 2021)

Ultimately, Uganda's legislative trajectory serves as a "pluriversal" model for the Global South (Kabeer, N. 2024). By addressing historical power imbalances and protecting Indigenous intellectual property within its national laws, Uganda is proving that the restoration of an ancestral ethic of stewardship is not a retreat from modernity, but a sophisticated advancement



toward a more resilient and ethically grounded global environmental policy. (Government of Uganda 2019)

3. Research Design and Methodology

3.1. Research Paradigm and Design

This paper employs a qualitative research methodology, primarily relying on a comprehensive narrative review of secondary data to explore the integration of indigenous knowledge systems (IKS) into contemporary environmental policy. Unlike a systematic review that focuses purely on quantitative outcomes, a narrative synthesis allows for a deeper exploration of the "experiential epistemology" and "spiritual ethics" that define indigenous stewardship. This approach is critical for capturing the nuances of cultural governance that are often omitted from data-driven Western scientific reports.

3.2. Research Approach

The study utilizes a Tri-Sectoral Approach to data collection and analysis. This approach is designed to bridge the gap between formal state records and informal community wisdom, ensuring that the "experiential epistemology" of Indigenous groups is balanced with the structural realities of modern law.

3.3. Research Method

The method involves a comprehensive narrative review of secondary data. It synthesizes information from three distinct domains: academic literature, official policy documents, and indigenous community records/grey literature. This longitudinal view tracks the scholarly shift from marginalization to recognition.

By synthesizing information from three distinct domains, the study ensures that the "experiential epistemology" of Indigenous groups is balanced with the structural realities of modern law. (Vidal, T., et al. 2024)

The first sector involves a comprehensive analysis of *Academic Literature*. The research draws from peer-reviewed journals specializing in African ecology, ethno-biology, and environmental law. A particular focus is placed on bibliometric trends in African Indigenous Knowledge Systems (IKS) spanning the period from 1990 to 2020 (Malapane et al., 2022). This longitudinal view allows the paper to track the scholarly shift from the marginalization of local knowledge toward its current recognition as a "vital component of sustainable resource management." (Malapane, A., et al. 2022) By evaluating historical academic discourse, the research identifies the theoretical frameworks, such as bioculturalism and pluriversalism, that are most effective in challenging anthropocentric policy models. (Kabeer, N. 2024)

The second pillar of the data strategy is the evaluation of *Official Policy Documents*. A rigorous analysis of Ugandan legislative frameworks serves as the primary evidence for the nation's "legal evolution." Key documents include the landmark National Environment Act of 2019, which codifies the "Rights of Nature," as well as various district-level ordinances that formalize customary land use. By examining these official records, the study delineates the transition from colonial "fortress conservation" to a "relational model of reciprocity." This sector of data provides the institutional context necessary to understand how traditional stewardship can be



integrated into a modern state bureaucracy without losing its cultural essence. (Kimmerer, W. R. 2002)

To establish a rigorous foundation for the "ancestral ethic of stewardship," this research transitions from a broad continental survey to a concentrated analysis of the Ugandan landscape. The selection of specific case studies is not arbitrary but is designed to provide a representative cross-section of the diverse socio-ecological interactions that define the nation. While the paper acknowledges broader African perspectives, it specifically analyzes case studies from Uganda to delineate how indigenous governance structures have historically fostered environmental stewardship and continue to influence contemporary policy.

3.4. Population and Sample

The selection criteria for these case studies, focusing on the *Batwa* of the Bwindi and Mgahinga forests, the *Baganda* of the Lake Victoria basin, and the *Karamojong* of the northern rangelands were predicated on three primary scholarly requirements. The first of these is Ecological Diversity. By selecting communities situated within forest, wetland, and arid rangeland ecosystems, the study ensures that its findings are not limited to a single biome. Instead, it demonstrates how indigenous "experiential epistemology" adapts to vastly different environmental pressures, providing a comprehensive view of biodiversity governance across the Ugandan map.

Secondly, the research prioritizes the *Longevity of Practice*. Each of the selected communities maintains indigenous systems with documented histories of sustainable resource management that significantly predate colonial-era "fortress conservation" efforts (Brockington, D. 2002). The Batwa's forest-dwelling wisdom, the Baganda's totemic clan structures, and the Karamojong's migratory patterns represent centuries of accumulated ecological intelligence. By examining these long-standing practices, the paper identifies the "relational model of reciprocity" that allowed these ecosystems to remain resilient prior to the introduction of anthropocentric, state-centric management. (Kimmerer, W. R. 2002)

Finally, the study accounts for *Modern Policy Interaction*. These communities were specifically chosen because they are currently navigating the complex intersection of customary law and state environmental regulations. Whether it is the Batwa's struggle for recognition within National Park boundaries or the Baganda's influence on the National Environment Act of 2019, these cases provide real-world data on how "biocultural principles" can be integrated into modern governance. This focus allows the paper to move beyond historical nostalgia, offering a "pluriversal" perspective on how the ancestral ethic can be restored to address modern ecological challenges such as climate change and habitat loss. (Kabeer, N. 2024)

By analyzing these three distinct yet interconnected groups, the study builds a robust argument for a pluralistic approach that recognizes indigenous knowledge as a "vital component of sustainable resource management" (Malapane et al., 2022). This targeted methodology ensures that the final synthesis is grounded in the lived realities of those who have acted as the primary custodians of Uganda's natural heritage for generations.

3.5. Research Instrument

The primary research instrument is a Biocultural Analytical Framework. This theoretical tool operates through: i) *Comparative Mapping*: To identify divergences between anthropocentric



Western policies and indigenous relational models. ii) *Thematic Coding*: To categorize traditional practices (e.g., totems, migration) into functional ecological categories (e.g., biodiversity conservation, climate adaptation). *Integration Modeling*: To assess how biocultural principles can be synthesized into modern policy.

This framework serves as a critical lens to move beyond the "anthropocentric model of exploitation" toward a "relational model of reciprocity." (Kimmerer, W. R. 2002) The analysis is operationalized through three distinct methodological phases: comparative mapping, thematic coding, and integration modeling.

The initial phase of the analysis involves *Comparative Mapping*. This process is designed to identify the fundamental points of divergence between anthropocentric Western policies, which frequently externalize environmental costs in favor of industrial growth, and the deeply rooted relational models found in Ugandan indigenous cultures. By mapping these two worldviews, the study highlights how colonial-era "fortress conservation" created a systemic disconnect between the state and the land. This mapping is essential for visualizing the "epistemological displacement" that occurred when techno-rationalist approaches overrode ancestral ethics.

Building upon this comparison, the research employs *Thematic Coding* to categorize diverse traditional practices into specific, functional ecological categories. Rather than viewing indigenous customs as mere folklore, this coding identifies their roles in "biodiversity conservation, ecosystem-based adaptation, and climate resilience." For example, totemic restrictions are coded as a mechanism for species preservation, while the migratory patterns of the Karamojong are analyzed as a sophisticated form of climate adaptation. This systematic categorization allows the paper to present indigenous knowledge as a "vital component of sustainable resource management" (Malapane et al., 2022) that can be communicated to modern policymakers in a language they recognize.

The final stage of the framework is *Integration Modeling*. This phase assesses how "biocultural principles" can be effectively synthesized into modern policy frameworks to address historical power imbalances (Ijatuyi, O. O., et al. 2025). The model specifically focuses on mechanisms to "safeguard indigenous intellectual property," ensuring that community-based knowledge is protected from biopiracy. By assessing the viability of "decentralized authority," the study explores how the state can empower "custodian clans" to take the lead in environmental stewardship.

By employing this multi-layered qualitative approach, the paper aims to provide a "*pluriversal*" perspective that recognizes and legitimizes diverse ways of knowing and relating to the natural world (Kabeer, N. 2024). This framework moves the conversation "beyond tokenistic inclusion toward true policy integration," arguing that the sustainable future of Uganda's environment depends on a governance model that is both scientifically robust and culturally resonant. This analytical path ensures that the "restoration of the ancestral ethic" is treated not as a return to the past, but as a sophisticated evolution of environmental governance.

3.6. Data Collection

Data was collected from three primary sources: i) *Academic Literature*: Peer-reviewed journals on African ecology, ethno-biology, and environmental law (1990–2020); ii) *Official Policy Documents*: Ugandan legislative frameworks, including the National Environment Act of 2019



and district-level ordinances; iii) *Grey Literature & Community Reports*: Reports from NGOs (e.g., AFIEGO, Minority Rights Group) and community records detailing the lived reality of these groups.

3.7. Ethical Considerations

While this study relies on secondary data, ethical considerations regarding the representation of Indigenous knowledge are paramount. The research adheres to the principle of epistemological justice, ensuring that oral traditions and spiritual beliefs are treated as valid intellectual contributions rather than myths. The study also advocates for the protection of Indigenous intellectual property and critically examines power imbalances in the sources utilized.

4. Results

4.1 The Ancestral Ethic in Practice

The qualitative analysis of Ugandan indigenous systems and contemporary environmental data reveals a consistent framework of "relational stewardship" that functions across diverse biomes. The findings indicate that indigenous knowledge systems (IKS), deeply rooted in cultural norms and spiritual beliefs, emphasize a harmonious coexistence with nature and advocate for sustainable resource management practices that often predate Western conservation efforts. (Malapane, A., et al. 2022)

A foundational revelation of this research is that Ugandan indigenous sustainability operates as a lived philosophy rather than a static legal code. This system is deeply embedded within oral traditions, totems, and communal regulations, manifesting what scholars term an "*experiential epistemology*." (Vidal, T., et al. 2024) Within this worldview, humans are not positioned as "separate masters" of the environment, but rather as "integral parts of the ecosystem" (Vidal et al., 2024). This ontological perspective shifts the objective of environmental management from exploitation to a relational model of reciprocity. (Kimmerer, W. R. 2002)

The practical application of this interconnectedness is most visible in the *Baganda Totem System* (Mugisha, A. R. 2021). Findings indicate that the *Kika* (clan) structure functions as a sophisticated, decentralized biological conservation network. In this system, each clan is assigned the stewardship of a specific animal or plant species, which serves as their totem. Because harming or consuming one's totem is strictly forbidden by cultural taboo, the responsibility for biodiversity is distributed across society. This ensures that "no single species is over-exploited by the entire population," effectively creating a cultural safeguard that pre-dates modern endangered species legislation. (Mugisha, A. R. 2021)

This intelligence is further exemplified by the *Batwa's "Forest Intelligence"* in the Bwindi Impenetrable Forest. Analysis of community records and oral histories reveals that Batwa movement and resource extraction were historically synchronized with the forest's natural rhythms. Their presence was "dictated by the flowering cycles of plants and the migratory patterns of wildlife," ensuring that the harvesting of forest products, such as wild honey and medicinal roots, "never exceeded the rate of natural regeneration." This level of precision demonstrates that indigenous stewardship is not merely passive coexistence, but an active, data-driven management style rooted in generations of direct observation.



After examining these case studies, it becomes clear that restoring an "ancestral ethic of stewardship" involves legitimizing these experiential ways of knowing. Recognizing the Baganda totem system and Batwa forest intelligence as valid "long-term observational data" allows modern policy to transition toward a more "pluriversal" governance model (Kabeer, N. 2024). This approach moves beyond tokenism, acknowledging that indigenous communities hold the "experiential epistemology" necessary to navigate contemporary ecological challenges and ensure a sustainable future for both human and "other-than-human actors."

4.2 Place-Based Stewardship and Virtue Ethics

A central finding of this research is the transformative power of *place-based stewardship*, a framework that fosters a unique environmental virtue. In this model, human well-being is not viewed as an independent metric but is "inextricably linked to the health of the local ecosystem." This perspective encourages a deep, localized commitment to conservation that transcends the transactional nature of modern environmental management, grounding ecological health in the social and spiritual survival of the community.

The practical application of this stewardship is most evident in the management of *Sacred Natural Sites (SNS)*. The study identifies that across Uganda, particularly among the Bagungu in the Buliisa district, critical groves and water sources are governed by dedicated "custodian clans." These sites function as vital biodiversity hotspots because all forms of resource extraction are strictly forbidden by cultural taboo. By maintaining these areas as "refugia," indigenous governance provides a high level of protection for rare species that often exceeds the effectiveness of state-enforced protected areas.

Furthermore, the research highlights how these systems contribute to *Climate Resilience* by providing precise, "ecosystem-based adaptations" to modern ecological crises. For instance, Karamojong pastoralists utilize traditional weather forecasting, derived from the close observation of bird migrations and the budding cycles of specific trees, to manage their rangelands effectively. These "active, experiential epistemologies" allow communities to adapt to shifting climate patterns with a level of accuracy and local relevance that purely quantitative scientific models might overlook, ensuring communal resilience in the face of a changing climate.

The data collected suggests that indigenous governance structures often outperform top-down state interventions in specific ecological and social metrics. This effectiveness is largely attributed to the shift from a "policing" model to a "stewardship" model, where environmental protection is seen as a communal responsibility rather than an external imposition. By comparing these systems, the research highlights the limitations of the anthropocentric model of exploitation when contrasted with the relational success of ancestral ethics.

A primary indicator of this success is found in *Compliance Levels*. In areas where customary laws and traditional leadership are respected, there is a higher degree of community compliance compared to regions governed solely by the Uganda Wildlife Authority (UWA) rangers. The findings indicate that while state enforcement often relies on the "fear of punishment," indigenous systems are built upon "shared values and spiritual accountability." This internal motivation leads to a more sustainable, self-regulating form of conservation that does not require the heavy financial or human resource overhead of state-led surveillance.



Furthermore, the *Restoration of Degraded Lands* provides clear evidence of the superiority of local "experiential epistemology" in practical application. Indigenous "community-based regulations" have proven more effective in restoring degraded wetlands in the Lake Victoria basin than standardized state programs. This success stems from the use of deep, "long-term observational data" regarding historical water levels and native species succession. By utilizing this place-based wisdom, local communities can implement restoration strategies that are ecologically precise and culturally supported, ensuring that the recovery of the ecosystem is both rapid and permanent.

4.3 Summary of Findings

Ultimately, the results demonstrate that IKS are not historical relics but are active, experiential systems that provide solutions for biodiversity loss and climate resilience. The restoration of this ancestral ethic, transitioning environmental governance from a model of exploitation to one of reciprocity, is supported by the evidenced success of these community-led models.

Navigating the Intersection of Tradition and Modernity

The findings of this research highlight a fundamental ontological clash between conventional environmental governance and the "ancestral ethic of stewardship" practiced by Ugandan Indigenous communities. This discussion explores the implications of this divergence and the necessity of a pluralistic, relational approach to policy. (Ijatuyi, O. O., et al. 2025)

4.1 The Anthropocentric Gap and the Externalization of Nature

Current environmental policies in Uganda, often influenced by global neoliberal conservation models, frequently prioritize economic development, such as infrastructure projects and large-scale agriculture, over ecological integrity. This perspective is rooted in an anthropocentric view where nature is treated as an "externality", a resource to be exploited rather than a partner in survival.

In contrast, the Indigenous perspective revealed in the results demonstrates a "relational model of reciprocity" (Ijatuyi, O. O., et al. 2025). When the Baganda protect their totems or the Bagungu guard their sacred sites, they are not merely performing a "service" for the environment; they are maintaining a social and spiritual contract with the landscape. The divergence between these two views underscores why top-down policies often fail: they lack the cultural resonance necessary to inspire voluntary community stewardship.

5.2. The research underscores that integrating diverse knowledge systems, scientific, local, and Indigenous, leads to more effective biodiversity governance. However, the effective integration of these systems into mainstream policy requires moving beyond "tokenistic inclusion." Tokenism occurs when Indigenous people are "consulted" without having actual decision-making power, or when their knowledge is selectively used to validate scientific findings but ignored when it contradicts dominant economic interests.

True progress necessitates a "pluriversal" approach to governance, which recognizes that multiple valid ways of relating to the world can coexist within a single policy framework (Kabeer, N. 2024). In the Ugandan context, this starts with *Legitimizing Diverse Ways of Knowing*. This requires the state to recognize that oral traditions and spiritual taboos are not mere myths, but are "valid forms of ecological data and regulatory mechanisms" that have successfully managed landscapes for centuries.



Furthermore, a pluriversal model must focus on *Addressing Power Imbalances* (Kabeer, N. 2024). This involves acknowledging that colonial history systematically marginalized indigenous voices and that modern policy must actively work to "redistribute authority back to local custodian clans." By returning decision-making power to these traditional stewards, governance shifts from a top-down mandate to a relational partnership. (Ijatuyi, O. O., et al. 2025)

Finally, this transition requires *Safeguarding Intellectual Property*. It is essential to ensure that as Indigenous knowledge is integrated into scientific and legal frameworks, the communities themselves retain ownership. Effective policy must provide robust protections against biopiracy and cultural appropriation, ensuring that the "ancestral ethic of stewardship" remains a source of community empowerment rather than a resource for external exploitation.

5. Conclusion

The transition from colonial exclusion to the recognition of Indigenous Knowledge Systems (IKS) represents more than a policy shift; it is a fundamental ontological return to an *ancestral ethic of stewardship*. This review has demonstrated that the historical marginalization of Ugandan indigenous populations was not merely a byproduct of conservation, but a systematic erasure of "experiential epistemologies" that had successfully maintained ecological balance for millennia. By deconstructing the "fortress conservation" model, it becomes clear that the path to ecological resilience lies in reconciling modern state authority with these deeply rooted, relational models of reciprocity.

The evidence from the Batwa, Baganda, and Karamojong case studies confirms that IKS offers "precise and straightforward solutions" to contemporary crises, particularly through *Ecosystem-Based Adaptation* and decentralized biological conservation networks like the totem system. These findings suggest that indigenous governance often outperforms conventional top-down interventions by fostering a "place-based virtue" that relies on shared communal values rather than punitive enforcement. Consequently, the restoration of these systems is not a retreat into the past, but a sophisticated strategy for a "pluriversal" future where scientific data and ancestral wisdom function as complementary pillars of governance.

Ultimately, for Uganda to remain at the vanguard of global policy discourse, it must move beyond "tokenistic inclusion" and embrace true structural reform. This necessitates the legal validation of spiritual and oral traditions, the redistribution of authority to "custodian clans," and the robust protection of indigenous intellectual property. By operationalizing the "Rights of Nature" through the lens of indigenous stewardship, Uganda can provide a global blueprint for a sustainable future, one that honors the inextricably linked well-being of both human and "other-than-human" actors. (Ijatuyi, O. O., et al. 2025)



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Workforce Diversity and Team Performance in Municipal Service Delivery

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Abstract

This study investigated the relationship between workforce diversity and team performance in the Department of Community Services within the City of Matlosana Municipality, located in the North West province of South Africa. Given the country's diverse demographic landscape, the research examines explicitly how diversity across race, gender, and other factors influences team dynamics and impacts organisational performance, particularly in addressing service delivery challenges. The impact of diversity on team performance within any organisation has critical value for the collaboration and realisation of organisational goals. The Municipality has faced significant performance challenges, especially in service delivery. The study specifically focused on the Department of Community Services employees, in the Cleansing Refuse Removal Section, to explore factors influencing the perceptions on the impact of diversity on team performance. Qualitative research design was employed, using interviews to capture participants' experiences, perceptions, and narratives. From a sample of seven participants, findings revealed several barriers to effective service delivery by a diverse workforce, such as poor diversity management limiting the potential benefits of diversity within a workforce, political interference based on cultural background, resource challenges stemming from inadequate equipment, delayed procurement, and poor communication from leadership leading to inefficiencies, as well as insufficient community engagement in waste management. The study underscored the importance of adequately managing diversity, improving leadership communication, and engaging with the community to enhance municipal service delivery and performance. Recommendations included the formulation of policies that support ongoing diversity awareness programs to foster cultural competence and improve team collaboration; leadership training to improve inclusivity and communication, revising diversity policies to ensure equal representation, and organising team-building workshops to promote collaboration among diverse employees. Transparent feedback processes and employee recognition were mentioned as being capable of building cohesion among the diverse employees. These outcomes directly support Sustainable Development Goal (SDG) 11 (Sustainable Cities and Communities) and SDG 16 (Peace, Justice and Strong Institutions). The study contributes to sustainability and governance policy discourse by demonstrating that workforce diversity is a strategic institutional asset rather than merely a compliance requirement.

Keywords

diversity, inclusivity, municipality, service delivery, team performance

Introduction

Workplace diversity in South Africa presents a crucial aspect in the attainment of a successful and inclusive work environment, embodying factors such as gender, race, sexual orientation, age as well as cultural background. The nation's historical past calls for the addressing of



previous inequalities and for the promotion of fair and equal representation across all levels of employment. This paper researches the impact of diversity on team performance in South African local municipalities, beginning with a background that outlines the socio-economic, historical as well as legislative developments which influence workplace diversity.

Background

In the dynamic South African context, diversity is fundamental to the country's cultural and national identity (Bornman et al., 2024). Scholars have defined diversity in numerous ways (Shore, Cleveland & Sanchez; 2021, Tiwarim, 2022), but in the context of this research, diversity will be taken to mean the presence of employees of varied backgrounds, experiences and perspectives in an organisation, including differences in ethnicity, race, age, gender, sexual orientation, religion, disability, as well as socioeconomic status. It also involves diversity in thought, skills, and professional backgrounds. The underlying principle of workplace diversity involves the creation of an environment that is inclusive; and where everyone feels respected and valued, and where a wide range of viewpoints can be tolerated and incorporated towards organisational success.

Prior to democracy, the South African labour market was characterised by apartheid-era policies that enforced racial segregation and discrimination, as well as restricting black South Africans from accessing skilled jobs and higher wages, relegating them to low-paying, manual labour roles (Pellicer & Ranchhod, 2023). This system led to economic inequality and limited opportunities for black workers (Gouzoulis, Constantine & Ajefu, 2023). After the transition to democracy in 1994, significant changes occurred in the South African labour market, with the new government introducing labour reforms aimed at eliminating unfair discrimination, promoting equality and creating a more inclusive labour market, with the most notable changes being the introduction of the Labour Relations Act (LRA) of 1995; the Employment Equity Act (EEA) of 1998 and the Broad-Based Black Economic Empowerment (B-BBEE) Act 53 of 2003. (Republic of South Africa 1995, Republic of South Africa, 1998, Republic of South Africa, 2003).

Globalisation has become a major contributing factor towards diversity dynamics in South Africa (Green, 2009). In prioritising the growth of local economies and the provision of infrastructure and services, local municipalities employ employees from diverse backgrounds and cultures with varying experiences (Pieterse et al., 2013).

There are three spheres of government; national, provincial and local, which are interdependent and interrelated. The municipality is the sphere of government that is closest to the people. According to Section 152 of the Constitution of South Africa of the Republic of South Africa Act 108 of 1996, local government oversees meeting municipal goals and ensuring that the needs of local communities are met through the delivery of essential services like water, sanitation, and refuse collection in communities (Republic of South Africa, 1996). To enhance public service efficiency and accountability, the South African government introduced the Batho Pele principles, which focus on citizen-centred service delivery. These principles include consultation, service standards, access, courtesy, information, openness and transparency, redress, and value for money (Republic of South Africa, 1997).

Despite these principles, challenges persist in municipalities, affecting governance and service efficiency (Mdlongwa, 2014). The impact of diversity on team performance in an organisation holds immense value for collaboration and achievement of organisational goals (Bell & Brown, 2018). While the importance of a diverse and inclusive workforce is well



recognised, the unique socio-political history, cultural dynamics and challenges faced by municipalities necessitate a focussed exploration of how diversity influences team performance (Mlambo, Zubane & Thusi, 2022). Similar research conducted in other contexts might not be applicable to a South African local municipality, underscoring the need for a context specific study.

Problem Statement

There has been growing recognition in organisational and management research of the critical role diversity plays in team performance (Van Knippenberg, 2021), emphasising that workforce diversity has evolved to significant importance.

Performance within municipalities was often hindered by several operational challenges, which contributed to the failure in providing communities with long-term fundamental services (Mlambo et al., 2022:15). The impact of diversity in team performance was brought to the fore by Berber, Slavić and Aleksić.,(2020), as well as by Van Knippenberg, 2021, as one of the aspects that indeed presents serious dynamics in service delivery, particularly in the South African context, where inadequate resources, historical injustices, and societal divisions based on race, gender, and ethnicity persisted (Booyesen & Nkomo, 2014).

Team diversity can present positive impacts within a municipality, as well as challenges. Team diversity, when managed well, can be a strength that is capable of improving the responsiveness, effectiveness and fairness of municipal service delivery. Many local government institutions struggle to manage this diversity effectively. A problem surfaces when there is improper management of this diversity, which often results in internal conflicts, communication breakdowns, as well as low staff cohesion, which ultimately will hamper the outcomes of service delivery. This will result in citizens expressing their dissatisfaction with the inadequate provision of services and the prevalence of poor practices through service delivery demonstrations (Mdlongwa, 2014). The occurrence of violent demonstrations related to service delivery nationwide has increased (Mamokhere & Kgobe (2023; Chili et al., 2023), clearly indicating an overall decline in municipal performance (Mlambo et al., 2022).

The main research question of this study is: How does diversity influence team performance and decision-making in a local municipality in the North West province? By investigating various dimensions of diversity in relation to team performance, the study pursued to provide nuanced insights that could inform policy decisions and management practices.

Research objectives

The objectives of the study are::

1. Investigate how employee characteristics influenced team performance
2. Assess the effectiveness of diversity initiatives and inclusive leadership in addressing team performance challenges and improving service delivery
3. Explore how inclusive leadership and effective management strategies improved team performance and addressed communication challenges in diverse teams

The literature review in support of this study will be presented, followed by the research methodology and the results and findings.



Literature Review

Factors influencing diversity

Gross-Gołacka, Kupczyk and Goacka (2022) contend that globalisation, rising life expectancies, employee characteristics and human rights awareness can all contribute to diversity. According to studies by Deloitte (2020), diversity in teams encompasses both advantageous and disadvantageous facets. The benefits of diverse teams are (i) increased capability of generating innovative and creative ideas, (ii) effective solutions to complicated challenges and (iii) attainment of superior outcomes. Moreover, studies show that diverse teams can present valuable perspectives and innovative ideas (Van Knippenberg et al., 2018). A notable disadvantage is that diverse teams may encounter incidences of misunderstanding and conflict, resulting in decreased levels of team effectiveness and cohesiveness (Berber et al., 2020; Pieterse et al., 2013). As a result, effective management of these dynamics is essential for achieving positive outcomes in diverse teams.

With regards to age diversity, Ng and Parry (2020) noted that this positively influences team problem-solving capabilities. While older employees contribute extensive experience, the younger ones offer innovative ideas and high adaptability. Kreitz (2008) concludes that teams with diverse educational backgrounds enjoy a wider range of problem-solving approaches as well as innovative thinking, although they may face challenges in the harmonisation of existent different methodologies. Additionally, gender diversity impacts communication styles and leadership within teams. According to Hardt, Mayer, and Rincke, (2023) all-male teams communicate more than all-female teams and outperform teams of both alternative gender compositions. Carli and Eagly, (2016) note that women often exhibit collaborative and participative communication styles, which can improve on team effectiveness and cohesion. Gender diversity in teams typically shows improved interpersonal communication and decision-making processes.

Team performance and diversity

Team performance includes the interactions through which individuals share knowledge, experiences, knowledge as well as skills to accomplish a common goal (Berber et al., 2020; Hoogendoorn & Praag, 2015). This can be achieved through the collaborative efforts of team members, who willingly undertake to do tasks that surpass the prescribed ones and at the same time demonstrate altruistic behaviours towards their colleagues (Salas & Fiore, 2004).

The Batho Pele principles provide a framework for the assessment of the effectiveness of teamwork in municipalities, ensuring that public servants prioritise the needs of the citizens, ease access to quality services, as well as uphold transparency and accountability in governance (Republic of South Africa, 1997). These principles reiterate the need for well-functioning teams in local government structures, since effective teamwork is critical for delivering efficient and citizen-centred municipal services.

Team performance is influenced by a variety of factors, such as diversity-related aspects, communication, trust among team members, shared goals, skills, conduct and effective leadership (van Knippenberg, 2004; Mazibuko & Govender, 2017). Team dynamics are mainly affected by communication, as team members may have different communication styles and preferences.

Trust and cultural biases in diverse teams

Trust is fundamental in team performance, particularly in diverse teams where it can assist in bridging differences and fostering collaboration (Costa, Roe. & Taillieu, 2001). Team cultural



diversity can enrich problem-solving abilities and innovation by integrating varied perspectives and experiences, but however, these differences can also cause misunderstandings and challenges in communication and collaboration. Building trust becomes necessary to harness diversity's potential benefits while mitigating its pitfalls. Meyer and Peng (2016) contend that trust is enhanced when members demonstrate respect and openness towards existent cultural norms and practices. This mutual respect is the foundation for effective communication and collaboration, allowing team members to effectively deal with cultural biases and stereotypes. Ng, Ang and Chan (2017) suggest that teams that actively undergo cultural sensitivity training and attend workshops tend to develop stronger interpersonal relationships and trust among members. When team members are transparent about their intentions and actions, it helps dispel misconceptions and fosters an environment of honesty and reliability (Mishra, 2018).

Dobbin and Kalev (2018) underscore the importance of managerial responsibility, dedication as well as the incorporation of diversity objectives into corporate strategies. Dobbin and Kalev (2018), further mention that proactive endeavours such as the implementation of diversity training programmes, assist in creating an inclusive workplace culture.

Role of leadership in fostering diversity and inclusion

Effective management of diverse teams requires inclusive leadership, the creation of psychological safety and clear communication to ensure everyone's voice is heard (Edmondson, 2019). These diverse perspectives support risk-taking, contributing to a more innovative and effective team environment. A study conducted by Homan et al. (2019) highlights the function of leadership in advancing and fostering the principles of diversity and inclusion.

Leaders who exhibit inclusive behaviours such as engaging in transparent communication, soliciting input from all team members and prioritising the attainment of diversity objectives, foster an atmosphere that is conducive to developing diverse teams and can enhance team performance. The provision of organisational support, encompassing implementing policies and procedures that cultivate inclusivity, is of utmost importance for improving outcomes related to fairness and inclusion (Dobbin & Kalev, 2018). On the other hand, according to Chokwe and Wright (2013), managers' lack of appreciation and support can easily demotivate staff. It is therefore important to appoint leaders who have the requisite ability as well as expertise to occupy the appropriate roles (Ng et al., 2017)

A sense of belonging is essential for integration and creation of psychological safety. Employee engagement activities such as employee resource groups, mentorship programmes and welcoming social events improved the sense of belonging (Dobbin & Kalev, 2018). Furthermore, reducing and raising consciousness of prejudice is essential to fostering acceptance and creating psychological safety. Training courses that educate employees about biases and offer methods for overcoming the said biases have been demonstrated to be effective (Dobbin & Kalev, 2018). Reducing prejudice in recruitment and selection procedures is possible by implementing blind hiring practices (Dobbin & Kalev, 2018), which contrasts with cadre deployment, whereby appointments are made based on a relationship with and loyalty to a specific political party (Shava & Chamisa, 2018; Mlambo et al., 2022), which results in poor performance, nepotism, cronyism and poor service delivery, especially in government institutions (Mlambo et al., 2022). It is important that leaders be subjected to a greater level of accountability by their followers, stakeholders and the broader community (Riggio et al., 2018).

Navigating communication challenges in the work environment



Clear communication is yet another crucial element in the management of workplace diversity. Effective management of diversity in any organisation necessitates the presence of clear communication and regular feedback to eliminate obstacles that will affect task efficiency and goal attainment (Mazibuko & Govender, 2017). The convergence of persons with diverse backgrounds and experiences raises the likelihood of the development of misconceptions and misinterpretations making effective dialogue and negotiation difficult (Saaida, 2023). To circumvent these dangers, it is important to communicate in a way that is easily understandable to all individuals.

Research Methodology

Research Paradigm

The study adopted an interpretivist paradigm, as it acknowledges the importance of context and the meanings individuals attribute to their experiences (Saunders et al., 2019). Under this paradigm, researchers aim to understand and interpret social phenomena through participants' perspectives, uncovering those subjective meanings that shape actions and interactions (Pervin & Mokhtar, 2022). The focus was on gaining insights into team performance from team members' perspectives.

Research Design

The study employed a phenomenological research design, which, according to Smith, Flowers & Larkin, (2021), seeks to understand and describe the structures and essence of human experiences as they appear in consciousness.

Cross-sectional time horizon

The study used a cross-sectional time horizon, which involved collecting data at a specific moment without recurring assessments, a process which provided an overview of the relationship between diversity and team performance in the municipality, allowing for a comprehensive understanding of the phenomenon at a particular point in time (Saunders et al., 2016).

Research methods

Qualitative methods were employed to explore perceptions concerning diversity and team performance; and were considered suitable since they allowed for a deep understanding of participants' lived experiences and the meanings that they attributed to them (Creswell & Poth, 2018).

Population

This research focused on employees in the refuse removal section of the Matlosana Municipality. The total population for the study consisted of 43 permanent employees.

Sampling

A sample of seven participants was purposively selected for the study, and was deemed adequate for a thorough investigation, in line with Etikan et al. (2020), who suggest a range of five to twenty-five participants for semi-structured interviews. Participants were required to have at least six months' experience within their roles, ensuring they had sufficient exposure to the complexities of team dynamics and diversity. Excluded were individuals with less than six months' experience or those whose responsibilities did not involve team interaction or



decision-making. This selection ensured that the sample included individuals with the required expertise to provide meaningful insights into the research focus, thereby enhancing the validity and depth of the qualitative data (Bryman et al., 2014).

Data collection

Semi-structured interviews

The researchers relied on semi-structured face-to-face interviews, each lasting between 20-30 minutes. This approach aligned with the recommendations of Bryman et al. (2014) and Saunders et al. (2019), offering a balance between structure and flexibility.

Before commencing the main data collection, an interview guide underwent pilot testing to ensure its effectiveness. Feedback from the pilot enabled necessary adjustments to ensure the tool's suitability for the study's objectives, and was thereafter, deemed suitable to be used. The interviews were coordinated by the assistant director of the section. Ethics approval for the study was obtained from North-West University, ensuring that the research adhered to ethical standards.

Data saturation was monitored throughout the data collection process, and saturation was determined to have been reached after the seventh interview, as no new codes or themes emerged from the data.

Demographic data collection

The inclusion of demographic factors in the study was important for several reasons. Firstly, understanding the diversity composition of South Africa's population, including variations in race, gender, age, and socio-economic background, was necessary for analysing how diversity impacted team dynamics (Gross-Golacka et al., 2022). Secondly, factors such as age, gender, and educational background do significantly influence team interactions and performance (Ng & Parry, 2020), particularly with gender diversity often improving communication and decision-making (Edmondson & Lei, 2021). Thirdly, for studying the composition of teams in accordance with South Africa's Employment Equity Act, 2022, which mandates fair representation and inclusion across demographic groups, which thus allowed the study to investigate the effectiveness of current policies and practices in enhancing team performance (Republic of South Africa, 2022).

Data analysis

The data were submitted to ATLAS.ti 24, identifying patterns and following an iterative, inductive approach to code patterns, transforming raw data into meaningful insights, and ensuring depth and validity in the analysis (Flick, 2018; Bryman et al., 2014; ATLAS.ti Scientific Software Development GmbH, 2024).

While ATLAS.ti 2024 assisted in uncovering hidden relationships in the data, this did not replace the researchers' interpretive role. While the software organised and visualised patterns, the researchers maintained critical engagement to enable rigour of the analysis when presenting and discussing the findings (Saunders et al., 2019).

Table 1 below outlines the thematic analysis process followed in the study.

Step	Description
Data collection	The responses regarding diversity, teamwork, leadership, and organisational challenges were gathered from employees at the Matlosana municipality.



Familiarisation with data	The data were read multiple times to identify recurring patterns, key points and overall content.
Generating initial Codes	Initial codes were created to identify important data features. Each response was coded to reflect relevant aspects.
Searching for themes	Codes were grouped into potential themes based on commonalities, namely, diversity management, team dynamics and leadership.
Reviewing themes	Themes were reviewed and refined, ensuring they accurately represented the data and were consistent with the research questions.
Defining and naming themes	Themes were clearly defined and given descriptive names to ensure clarity and coherence.
Writing the report	The final report was written, integrating the themes, codes and relevant data to present the findings.

Ethics

Ethical considerations

Throughout the study, ethical principles such as participant confidentiality, voluntary participation, and transparency in data collection were prioritised, to ensure the integrity and reliability of the findings, as well as adhering to the established ethical standards.

- Informed consent: Clear and comprehensive informed consent forms in both Setswana and English were availed to accommodate diverse participants, and participant's right to withdraw at any time were addressed (Adams, Khan & Raeside, 2014).
- Confidentiality and privacy: The researcher used codes to safeguard participants' confidentiality. All data handling and storage complied with the Protection of Personal Information Act (POPIA),
- Respect for autonomy: participants' rights were respected as they were free to make their own decisions about participating in the study
- Equity and justice: Participants were treated with equal respect and fairness.

These ethical measures ensured that the research process was conducted while respecting participants' rights and in compliance with the ethical standards required for academic research.

Results and Findings

The research findings are structured to align with the research aim and objectives. The discussion integrates participants' perspectives with relevant literature.

The findings are divided into two main sections: participant demographics and thematic findings. The participant demographics present an overview of the research sample, providing context for understanding the diversity of the workforce and its potential impact on team dynamics and performance. The section on thematic findings is divided into four key themes, each encompassing sub-themes that reflect the participants' perceptions.

Participant demographics

Table 2 below presents the demographics of the participants.



Table 2: Participant demographics

Participant	Age	Gender	Ethnicity	Geographic Location/Province	Highest level of Education	Years of experience
R1	48	Male	Tswana	North West	12	23 years
R2	55	Male	Xhosa	North West	11	10 years
R3	52	Male	Tswana	North West	12	20 years
R4	40	Male	Sotho	North West	Diploma in Marketing	1year
R5	27	Female	Tswana	North West	Grade 12	10 months
R6	39	Male	Tswana	North West	Grade 10	2.5 years
R7	48	Male	Tswana	North West	Grade 12	5 years

Age range

The participants' ages ranged from 27 to 55 years, representing a mix of younger and older employees. This age variation suggests that generational perspectives may influence problem-solving approaches, workplace interactions and attitudes toward organisational policies (Ng & Parry, 2020). Older employees may rely on established practices and institutional knowledge, while younger employees may introduce innovative approaches and fresh perspectives to workplace challenges (Kooij, Jansen & Dikkerset, 2020). Effectively managing these generational differences effectively could enhance team cohesion and productivity by leveraging the strengths of both experienced and emerging professionals (London & Smither, 2020). Generational diversity influences workplace performance, while other research suggests that mixed-age teams benefit from knowledge exchange and mentorship but may also encounter challenges related to communication and adaptation to technological advancements (Edmondson & Lei, 2021).

4.2.1.2 Gender representation

Participants were mostly male, with only one female participant. This imbalance revealed a gender discrepancy in the garbage removal sector, possibly affecting diversity management workplace interactions and inclusion efforts (Holtom & Lewis, 2020). This may reflect societal patterns where physically demanding and labour-intensive jobs are often male-dominated (Rosenkranz & West, 2021). Structural barriers, including gender stereotypes, limited recruitment efforts targeting women, and workplace cultures that may not fully accommodate female employees, could contribute to this disparity (Carter & Silva, 2020).

The absence of gender diversity may also influence team dynamics and decision-making processes. Research suggests that gender-diverse teams tend to exhibit improved collaboration, problem-solving, and inclusivity (Homan, 2019), but however, in environments where one gender significantly dominates, perspectives may become homogenised, potentially limiting innovation and adaptability (Ng & Burke, 2021). Addressing gender imbalances through targeted recruitment strategies, inclusive workplace policies, and support structures for female employees could enhance diversity and contribute to a more equitable work environment (Dobbin & Kalev, 2018).



4.2.1.3 Ethnicity

The participants in the study belonged to three ethnic groups: Tswana, Xhosa, and Sotho. The majority were Tswana, reflecting the dominant ethnic composition of North West (Chaka & Adanlawo, 2023). The presence of Xhosa and Sotho individuals indicated some level of ethnic diversity within the workforce. Ethnic diversity, when effectively managed, can contribute to varied perspectives, enhance teamwork, and promote innovative problem-solving (Patrício & Franco, 2022). However, if not inclusively managed, diversity may remain underutilised, leading to missed opportunities for knowledge-sharing and collaboration (Mazibuko & Govender, 2017).

4.2.1.4 Geographic location

All participants resided in the North West, highlighting the regional scope of the study. The province's demographic composition, economic landscape, and social dynamics are crucial in shaping workforce diversity and organisational practices (Stats SA, 2023). Regional factors such as local employment policies, cultural norms, and access to education and professional development influence workforce integration (SACN, 2014). Understanding the geographic context is essential in assessing how diversity is managed and how regional conditions impact workplace inclusion and team performance (Sagan, Sitek & Szajnowska-Wysocka, 2020) and also determines the availability of infrastructure and support systems that could enhance or hinder employees' professional growth (Mamokhere & Kgobe, 2023).

4.2.1.5 Education levels

Educational qualifications among participants ranged from Grade 10 to a diploma in marketing, with the majority having completed secondary education. Only one participant had obtained a certificate, indicating a limited presence of higher education qualifications in the workforce (Bhorat, Kaplan & Mlatsheni, 2018). This suggested restricted access to tertiary education opportunities, which may be influenced by socio-economic barriers, limited career advancement prospects, and the perception that higher education is not essential for roles within the garbage removal sector (Mlambo, Zubane & Thusi, 2022).

The absence of formal qualifications beyond secondary education may also contribute to a lack of theoretical knowledge and critical thinking skills (Koma, 2010). Employees with only basic education might rely more on practical experience rather than strategic problem-solving approaches that could improve efficiency and innovation within the sector (Ng & Parry, 2020). Limited exposure to higher learning could also affect adaptability to new technologies, workplace policies, and evolving industry practices (Richard, 2020). Expanding access to training programmes, technical certifications, and skill development initiatives may help bridge the knowledge gap and enhance professional capabilities in the field (Deloitte, 2020).

4.2.1.6 Experience

Participants' work experience significantly varied, ranging from 10 months to 23 years. This range reflected a workforce that included seasoned professionals with substantial institutional knowledge and newer employees who contributed fresh ideas and perspectives (Berber et al., 2020). Employees with extensive experience were likely to possess deep organisational insights and expertise, which could enhance decision-making and mentorship opportunities (London & Smither, 2020). Conversely, those with fewer years of experience may have brought adaptability and new problem-solving approaches, contributing to workplace innovation (Duguid, Goncalo & Negy, 2012).



The combination of these different levels of experience provided opportunities for knowledge exchange, but it also required careful management to ensure effective collaboration and skills transfer within teams (Creswell & Poth, 2020). Without structured mentorship and training programmes, organisations risk a disconnect between experienced employees and new hires, which may lead to inefficiencies and reduced knowledge retention (Daniel, 2018).

Thematic findings

The thematic data analysis examined employee responses from the municipality's waste management team to address the research aim, which was to examine the influence of diversity on team performance in a local municipality in North West, as well as the three research objectives stated earlier.

Table 3 below presents the themes, sub-themes, and descriptions that emerged from the data analysis. The thematic categorisation offers insights into the factors influencing workplace diversity and performance, identifying strengths and areas that require intervention to enhance organisational effectiveness.

Table 3: Themes, sub-themes, and descriptions

Theme	Sub-theme	Description
1. Managing diversity and inclusion	Perceptions of diversity policies and programs	Employees' views on the effectiveness of the diversity policies and programs at the municipality.
	Inclusive leadership and communication	The effectiveness of leadership in promoting inclusivity and open communication.
2. Team characteristics and diversity	Team diversity and composition	The racial, gender, age and educational diversity in the teams at the municipality.
	Impact of background on diversity	How personal backgrounds influence interactions and perceptions of diversity in the workplace.
3. Team performance and challenges	Performance and accountability	Evaluation of team performance based on community satisfaction, speed and efficiency.
	Collaboration and communication	The role of collaboration and communication in overcoming challenges and enhancing team performance.
4. Organisational issues and improvements	Challenges with resources and political interference	Resource shortages, political interference and financial delays affecting organisational efficiency.
	Resource management and operational challenges	Issues related to resource allocation and operational inefficiencies like shortage or no personal protective equipment (PPE) and



		financial constraints are impacting the municipality's performance.
	Improved communication and staff engagement	The importance of better communication and increased staff engagement to improve diversity, performance and inclusivity in the municipality.

Theme 1: Managing diversity and inclusion

This referred to employees' perceptions of the organisation's diversity policies and initiatives. The responses indicated mixed evaluations, with some participants acknowledging the existence of policies while others pointed out gaps in implementation and effectiveness.

a) Perceptions of diversity policies and programmes

The sub-theme explored participants' views on the effectiveness of their organisation's diversity initiatives in creating an inclusive atmosphere. The responses highlighted contrasting opinions, some recognising the initiatives while others felt they were insufficient.

P1 noted that while Employee Assistance Programmes (EAPs) existed, they were not always effective in addressing employees' challenges, particularly financial and social issues, as Mor Barak (2021) suggested. P1 stated:

"Two or three staff members were already referred [to EAP], but I am not in a position to say if it was successful or not".

This response reflected uncertainty about the impact of these initiatives.

P2 questioned the efficacy of the organisation's diversity programmes, arguing that while they were acknowledged, they did not appear to address employees' needs meaningfully. P2 expressed that:

"We have diversity programs in place, but I don't think they really achieve anything substantial... I feel like the issues people face are not really being addressed properly".

This response pointed to a perceived lack of tangible benefits from diversity initiatives.

P3 felt that diversity policies did not effectively foster inclusivity, particularly in recognising employees' internal qualifications. P3 stated:

"They don't recognise us, even with certificates. Only for the department. If a post is advertised, people should be recognised internally first before appointing from outside".

This sentiment suggested frustration over the lack of internal recognition despite employees' qualifications.

b) Inclusive leadership and communication

Inclusive leadership was a recurring issue in participants' responses, with many highlighting the significance of effective communication in ensuring inclusivity. Participants noted that management engaged with staff through informal and direct communication channels. Participant 1 and Participant 2 described how leadership was receptive to feedback, particularly during meetings and through platforms such as WhatsApp groups. This finding supported research by Vega, Quezada and Cortés (2020), who assert that inclusive leadership involves facilitating open communication channels to ensure employees felt valued.

Participant 1 stated:



“Managers consistently attended to our feedback and concerns expressed during meetings”.

This reflected a perception that leadership was responsive to employee concerns. Similarly, Participant 2 emphasised leadership's attentiveness, stating,

“There was effective and clear communication between the team and management, exemplified by platforms such as meetings that enabled employee engagement on municipal issues”.

This response underscored the role of transparent communication in fostering inclusivity.

Theme 2: Team characteristics and diversity

This explored the diversity within teams at the municipality and its influence on team interactions, cohesion, and performance. Participants shared their experiences of working in teams with diverse members in terms of race, age, gender, and educational background. While diversity was recognised as a potential strength, challenges such as role segregation and subtle discrimination were also noted. The participants' reflections underscored the importance of inclusivity in harnessing the full potential of team diversity.

a) Team composition

The composition of teams in the municipality was diverse in terms of race, gender, age, and educational background. Despite some challenges, most participants expressed positive attitudes towards working in diverse teams, supporting findings by Shore, Cleveland, and Sanchez (2021), who argue that workplace diversity could enhance teamwork when managed effectively.

Participant 1 noted that his team consisted of members from various ethnic groups, stating, *“Four Coloureds, Xhosa, Tswana, no Whites”.*

This response suggested that while there was racial diversity, certain groups might have been underrepresented. Additionally, Participant 2 described interactions within diverse teams, highlighting occasional racial jokes that might have contributed to tensions. He stated,

“Ja, you ma Xhosa, staying in poor areas. Some people were not going to like it”.

This response indicated the presence of microaggressions, which, as described by Sue, Capodilupo, and Holder (2020), could undermine inclusivity.

b) Impact of background on diversity

The participants' personal backgrounds influenced their perceptions of diversity and collaboration with colleagues from different backgrounds. Participant 4 reflected on how personal upbringing shaped his understanding of diversity and influenced his interactions at work. He noted:

“My behaviour as a person does not start from here [the workplace]. It all starts from my home, my growing up, in my classroom. All that plays a big role in the formation of one's understanding about diversity”.

This highlighted the influence of cultural upbringing and personal experiences on perceptions of workplace diversity.

Participant 5 expressed ease in integrating with others, stating,

“As a South African, for me, it is easy to integrate with people as it is a multi-racial country with different sub-cultures and values”.

Her response underscored how personal openness to diversity facilitated inclusivity. Participant 6 shared a similar sentiment, stating,



"For me, I am easy; I can talk with anyone. It doesn't matter if you are old, young, black or white, beautiful or not. I can mix with anyone".

This indicated a highly inclusive mindset, which could help overcome potential barriers in a multi-ethnic work environment.

Theme 3: Team performance and challenges

This explored how team performance was evaluated and the challenges teams faced in achieving their goals. The participants highlighted both internal factors, such as collaboration and accountability, and external obstacles, including resource shortages and inefficiencies. The reflections emphasised the importance of teamwork, effective resource management, and addressing systemic challenges to enhance performance and service delivery.

a) Performance and accountability

Participants noted that team performance was primarily evaluated based on metrics such as community satisfaction, speed, and efficiency. However, they also highlighted recurring challenges, including delays, resource shortages, and equipment failures, which complicated efforts to meet performance expectations.

Participant 3 described how time efficiency was used as a KPI. He stated:

"We check at the time; let's say a site takes 2-3 hours, and we make it in 2 and half hours. Then we know we did a great job".

This reflected the emphasis on completing tasks within set timeframes as a measure of success. Similarly, Participant 1 underscored the role of community feedback in evaluating performance. He noted:

"Performance is measured by how the community responds, whether there are complaints or compliments".

This indicated that community perceptions were a central aspect of assessing team effectiveness. Additionally, Participant 7 emphasised time efficiency and cleanliness as key indicators of success. He stated:

"Time... must do it under four hours, and areas should be clean".

These responses demonstrated that performance was judged based on both task completion and the quality of service delivery. However, they also highlighted the pressures teams faced in meeting these expectations.

Participant 6 identified external constraints, such as issues with suppliers, as significant obstacles to performance. He stated:

"One of our bigger challenges is when suppliers do not get their money on time; then they stop their services, like not giving the trucks".

This highlighted how financial delays disrupted operations and hindered the municipality's ability to meet performance goals, aligning with Krause et al. (2021), who note that resource constraints were common obstacles in public sector organisations.

b) Collaboration and communication

Participants highlighted the significance of teamwork and open communication in overcoming challenges and maintaining cohesion within teams. Despite differences in background and personal characteristics, participants generally described positive team dynamics. For example, Participant 3 emphasised the importance of collaboration in addressing challenges, particularly during high-demand periods such as after public holidays. He stated the following:



"We motivate one another and work together. Three members work in front of the truck to ensure that the bins and bags are closed and closer to the street so that the other two at the back of the truck can load refuse easily on the truck".

This response illustrated how teamwork and role allocation facilitated efficient operations, supporting findings by Zaccaro, Foti and Keller (2018), who argue that successful teams relied on clear roles and responsibilities.

Participant 2 described informal communication as a key mechanism for conflict resolution, stating:

"If I have a quarrel with you, at the end of the shift, we will talk, and sure, the problem is resolved between us".

This reflected a culture of open dialogue, which contributed to team cohesion. It also shows how informal interactions helped build strong interpersonal relationships and fostered a supportive environment.

Theme 4: Organisational issues and improvements

This addressed the organisational challenges within the municipality, including resource shortages, political interference, and operational inefficiencies. Participants highlighted various factors that impacted their work environment and service delivery, and the challenges identified in this theme underscored the pressing need for better financial planning, resource allocation, and communication strategies in the municipality.

a) Resources and political interference

Participants consistently expressed concerns about the lack of essential resources, financial constraints, and political interference affecting service delivery. Many reported that broken or outdated equipment and delays in procurement negatively impacted their ability to perform their duties effectively. Additionally, political dynamics within the municipality were perceived as obstructing operations.

Participant 1 raised concerns about malfunctioning refuse trucks, stating:

"Refuse trucks are broken, or contracts for trucks have expired."

This indicated that expired contracts and outdated equipment hindered operations, leading to inefficiencies in waste collection.

Political interference was another significant issue. Participant 6 expressed frustration, stating:

"Big bosses and managers in the municipality must stop saying there is no money, and this politics must stop".

This suggested that financial constraints were exacerbated by political decisions, further complicating municipal service delivery.

These findings aligned with Sullivan and Chapel (2021), who argue that political interference and financial mismanagement contribute to inefficiencies in municipal governance. Ensuring better financial planning and depoliticising operational processes could improve service delivery.

b) Resource management and operational challenges

Participants elaborated on resource shortages, describing how delays in payments to service providers and the failure to procure necessary equipment impacted their work. The absence of reliable infrastructure, such as well-maintained trucks and personal protective equipment (PPE), significantly affected their ability to deliver services efficiently. Participant 1 explained:



"Refuse trucks are broken, or contracts for trucks have expired".

This statement reinforced the recurring theme of logistical failures that prevented effective service provision. Participant 2 highlighted procurement issues:

"If we do not get the equipment we need, it's difficult to keep up with the demands of the community".

This emphasised how inadequate resources contributed to inefficiencies in service delivery.

c) Improved communication and staff engagement

Participants emphasised the need for better communication between management and staff, as well as increased engagement in decision-making. Many believed that recognition of employees' contributions and transparent communication channels could improve morale and workplace satisfaction.

Participant 1 stressed the need for better staff recognition:

"We need better recognition of the contributions of employees, especially in relation to performance, and complaints should be addressed more promptly".

This response underscored the importance of valuing employees' efforts and responding swiftly to their concerns. In addition, Participant 2 proposed an initiative for community education on waste management, hoping management would recognise his input:

"Educate the community about the different waste, and to make a living off recycling. Start programs with schools where they have different containers for waste bottles, plastic, municipal waste, grass, etc".

This suggestion pointed to staff contribution towards the potential for community-driven solutions to improve municipal services.

Participant 3 also urged leadership to be more receptive to lower-level staff:

"Leadership must listen more attentively to staff in lower ranks".

This indicated that hierarchical barriers in communication limited employees' ability to share their concerns, and demonstrated that ineffective communication and a lack of staff recognition contributed to dissatisfaction and inefficiencies in the workplace. As supported by Kuvaas (2019), acknowledging employees' contributions and fostering open communication can significantly improve organisational morale and performance.

Managerial Implications

The study's findings informed local policymaking by providing ideas for cultivating inclusive work cultures, optimising team dynamics, and augmenting service delivery. They assisted local municipalities in South Africa to harness diversity as a source of strength that could enhance overall team performance.

Policy recommendations

Enhance resource management and operational efficiency

-The municipality should implement policies ensuring timely procurement and maintenance of essential resources, including waste management equipment and service vehicles.

-Policies should ensure timely contract renewals with respective service providers to minimise service delivery disruptions

- Ensure political neutrality in municipal operations



- Clear policies which separate political interference and operational decision-making should be put in place to enhance efficiency in service delivery
- Transparent governance measures should be introduced to prevent favouritism and promote resource distribution accountability

Recommendations for practice

- Improve communication channels for team coordination
- The municipality should implement structured communication frameworks, inclusive of open-door policies, regular feedback meetings as well as grievance resolution mechanisms
- Introduce digital communication tools to efficiently track service requests and complaints
- Promote employee engagement and recognition
- Introduction of employee recognition programs that acknowledge outstanding performance and contributions to service delivery
- To improve employee morale and encourage greater commitment to municipal goals, public recognition of exceptionally performing teams should be upheld

Apart from the practical contributions, this research also had theoretical implications, such as contributing to a deeper understanding of the relationship between diversity and team performance, thus adding weight to the existing literature.

Conclusions, Limitations and Future Research

According to a previous study by Deloitte (2020), diversity in teams has both advantageous and disadvantageous facets. The benefits of diverse teams are (i) increased possibility of generating innovative and creative ideas, (ii) effective solutions to seemingly complicated challenges and (iii) the attainment of superior and advanced organisational outcomes, while a possible disadvantage could be that diverse teams may frequently encounter incidences of misunderstanding and conflicts, resulting in reduced levels of team effectiveness and cohesion (Berber et al., 2020; Pieterse et al., 2013). Effective management of such dynamics in diverse teams is necessary for the achievement of positive organisational outcomes.

The findings of this research corroborated with previous research by highlighting that varied employee characteristics significantly influence team performance, and that effective management of resources, inclusive leadership, and open communication were perceived as critical for addressing performance challenges and enhancing service delivery. The findings also emphasised the need for enhanced resource management and supportive political backing to effectively bring about inclusive heterogeneous and multifaceted teams capable of addressing community needs.

Study limitations

Language issues presented difficulties in gathering data. Although the interviews were conducted mostly in English, not all participants spoke the language with the same level of proficiency. Translating research tools into participants' native tongues, as suggested by Braun and Clarke (2019), would have eased this limitation.

The quality and clarity of certain responses may have been impacted by different participants' varying levels of comprehension of the topic due to their varied educational levels. Notwithstanding these drawbacks, the study offers insightful information on how diversity affects team performance, and its conclusions can still guide future studies and industry practices.



Recommendations for future research

- Expand the participant pool: Future research should include a larger and more diverse participant group across various municipal departments and hierarchical levels to capture a broader spectrum of perspectives on team dynamics and performance (Mazibuko & Govender, 2017).
- Conduct longitudinal studies on diversity initiatives: An extended study duration would allow researchers to track the long-term impacts of diversity initiatives on team performance and service delivery outcomes (Mazibuko & Govender, 2017).



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Artificial Intelligence and Employability in Education: Research Trends and Future Research Agenda

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Abstract

Technological advancements are reshaping the traditional job markets and the skills required to succeed. The purpose of this study was to determine the current research landscape of artificial intelligence within the educational and employment fields. By examining research conducted both globally and specifically in South Africa, we uncovered meaningful insights for future research avenues to expand the body of knowledge related to this theme to probe theoretical and practical advancement in this sphere. The suggested future research themes aim to address the existing literature gap in this critical area of artificial intelligence, education, and employability. This study comprised a bibliometric analysis using VOSviewer and Biblioshiny. The bibliometric data were collected from the world's largest multidisciplinary peer-reviewed database, SCOPUS. A total of 5014 documents were obtained globally, and 53 for South Africa that comprised the broad keywords 'artificial intelligence', AND 'work' AND 'education'. Based on a meta-analysis of existing bibliometric data, this study is explicitly unique in that it integrates artificial intelligence, education, and employability. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines were obeyed throughout data collection. The results indicated that research on artificial intelligence, work, and education is primarily conducted in developed economies such as the United States, China, and the United Kingdom. This study yielded valuable insights by revealing a structural disconnect between artificial intelligence, education, and work studies in South Africa. Thus, recommendations to inform the development of this multidisciplinary field and the preparation of future graduates in South Africa have been proposed. Implications arise for educational institutions in ensuring that graduates remain competitive and adaptable in an artificial intelligence-driven world.

Keywords: artificial intelligence, bibliometric, education, South Africa, work, employability

1. Introduction

The future success of education depends heavily on staying relevant amid constantly evolving technologies and systems. The integration of artificial intelligence (AI) into various facets of society has sparked profound discussions about its impact on employment and the role of education in preparing individuals for the future workforce. AI is a computer-based application capable of processing and completing complex data tasks (Bhattacharjee, 2019). As technologies advance rapidly, questions arise about how these advancements reshape traditional job markets and the skills required to succeed (Rickardo & Meiriele, 2023). According to Ngotngamwong (2020), technological advancements in AI have created job uncertainties, prompting discussion of its effects on the working class and employability. [The](#)



[World Economic Forum's 2023 Future of Jobs report](#) predicts that nearly 70 million new jobs will be created globally, while 83 million will be eliminated by 2027 (Di Battista et al., 2023).

A significant portion of the current unemployed population consists of young people and graduates (Statistics South Africa, 2024). Based on this, graduate job seekers must acquire diverse employability skills to align with the modern workplace (Wahab et al., 2024). Key employability skills entail adaptability, critical thinking, working under pressure, work ethic, integrity, and effective communication. These are a combination of skills learnt and graduates' personal attributes (Wahab et al., 2024).

Current research on AI and employability emphasises the importance of education aligned with the labour market, given the global proliferation of AI use (Bhargava, 2023; Bhattacharjee, 2019). Fangquan et al. (2024) also found that technological developments, including AI, are essential to teaching methods and are key factors contributing to enhanced employability. While AI in education has gained research traction, its integration to enhance employability remains largely absent, particularly in South Africa.

This study, therefore, aimed to uncover the research trajectory of AI research in education and work. The research question: What are the gaps in the current research trajectory of AI, education, and work in South Africa and globally? The research question is essential to reveal through a bibliometric analysis, as a new digital era has begun, and the research landscape on such a theme requires immense advancement in South Africa. Consequently, responding to the call to identify current focus areas and trends within the research on artificial intelligence within the employment and education fields.

To achieve the study's primary objective, a comprehensive bibliometric analysis was conducted using data from a global and a South African focus. By delving into research conducted globally and locally specific, the study identified key future research avenues to minimise the knowledge gap in this critical area of education, employment, and AI in South Africa, thereby enriching the future of education learning systems and enhancing employment through recommended research avenues.

1.1. Background to the study

The current literature on AI in education should be considered to inform discussion and identify gaps in the field. Table 1 presents a brief overview of five current bibliometric studies on AI within the education and employment fields, detailing the aim, methods, and summary of the research findings. Based on the content in Table 1, research gaps are identified, underscoring the need for this bibliometric study.

The studies in Table 1 demonstrate that an updated bibliometric analysis is needed, as existing studies conclude in 2024. Additionally, the results primarily focus on developed countries and do not consider developing economies. Moreover, these studies lack emphasis on the concept of work or employment-related keywords to AI in education. Table 1 demonstrates that current bibliometric studies focusing on AI and education have used these terms to search the multidisciplinary databases SCOPUS and Web of Science. However, there is no reference to employment terms such as 'work' or 'labour' and a modest number of documents were used for analysis.

Table 1: Current bibliometric studies



Authors	Title	Aim of the study	Methods used	Summary of Findings
Batubara, Jalinus, Rizal, and Watrianthos (2024)	Mapping the Frontier: A Bibliometric Analysis of AI in Tertiary Education	Bibliometric analysis on AI applications in education.	412 documents obtained from Web of Science, which were published between 2014 and 2024. Search keywords entailed 'artificial intelligence' AND 'education' OR 'tertiary education'. Data was analysed using biblioshiny.	Results indicate an increase in publications on AI in education, with China leading in the number of publications on the theme. Followed by the United States and the United Kingdom.
Fernandes, Nagata, Melo, and Martins (2024)	Artificial intelligence and sustainability in education: A bibliometric analysis and its relations with the UN SDGs	To determine the importance of artificial intelligence and sustainability in education and its relation with the United Nations Sustainable Development Goals.	233 documents obtained from Web of Science. Keywords used to search the documents comprised 'artificial intelligence in education for sustainability' OR 'artificial intelligence for education for sustainability' OR 'artificial intelligence' AND 'education for sustainability' OR 'sustainability in education'. Data was analysed using VOSViewer.	The findings identified that AI enhances teaching methods in education and that there is a need for teacher empowerment in using AI to develop student's capabilities.
Hinojo-Lucena, Aznar-Diaz, Caceres-Reche, and Romero-Rodriguez (2019)	Artificial Intelligence in Education: A Bibliometric Study on its Impact in the Scientific Literature	To identify the literature on AI in education.	A total of 132 documents were collected from the Web of Science and SCOPUS, published between 2007 and 2017. Search keywords included 'artificial intelligence' and 'education'. Data was analysed using biblioshiny.	The findings recognised that AI in education is emerging, and research in the field is still in its early stages. The results showed that the United States led in the number of publications on the theme.
Maphosa and Maphosa (2023)	Artificial intelligence in education: a bibliometric	To recognise the research trajectory of AI in education.	304 documents collected from the SCOPUS database published between	The results identified that China, the United States, Russia and



	analysis and topic modelling approach		2012 and 2021. Data was analysed using VOSViewer.	the United Kingdom were leading publishers in the field.
Lopez-Chila, Llerena-Izquierdo, Sumba-Nacipucha, and Cueva-Estrada (2024)	Artificial Intelligence in Education: An Analysis of Existing Bibliometrics	To understand the current landscape of AI in education.	870 documents collected from the SCOPUS database published between 2017 and 2023. Search terms included 'artificial' AND 'intelligence' AND 'higher' AND 'education'. Data was analysed using VOSViewer.	The findings indicated that China and the United States were leading publishers in the field, with popular keywords entailing ChatGPT and machine learning.

Source: Authors' compilation

Moreover, current bibliometric studies primarily focus on education terms and do not consider publications using the keyword 'education'. Specifically, there is a lack of focus on South Africa, indicating a geographic imbalance in the existing literature. Consequently, these gaps provide a foundation for justifying this bibliometric study, which aimed to uncover the current research landscape and future research avenues in AI research in education and work. The following section discusses the research methods used to obtain and analyse the bibliometric data.

Given the synopsis of similar bibliometric analysis studies on AI in education, there is an explicit conceptual discourse integrating a multidisciplinary perspective of AI, education, and work, which requires addressing, as the graduate unemployment rate in South Africa is high, there is a need to develop scholars of the economy within this theme.

2. Research Design and Methodology

This study employed a quantitative methodology by executing a bibliometric analysis. A bibliometric analysis summarises specific bibliographical data to provide an overview of the academic research within a particular field or journal, which was a primary objective of this study (Rovelli et al., 2022; Shah et al., 2024). A bibliometric analysis was deemed suitable for this study as the aforementioned literature demonstrated that AI-related research in education and work is required.

For this study, the primary objective was to review the trajectory of AI research in education and the workforce. The secondary research objectives entailed identifying and comparing the core research themes and gaps between South Africa and the global landscape. Additionally, to provide recommendations for future research avenues based on the current trajectory of AI research in the education and employment fields (Wahab et al., 2024).

2.1. Data Collection

For this study, only one database was selected to obtain the required bibliometric data. Here, the SCOPUS database was selected as it is recognised for being the world's leading peer-reviewed multidisciplinary database (Nguyen et al., 2021). SCOPUS is a trusted, source-neutral abstract and citation database curated by independent subject matter experts who are



recognised leaders in their fields. The Department of Education and Training of South Africa recognises the SCOPUS database as an accredited source (DHET, 2022).

The selection of a single database was based on SCOPUS's in-depth journal coverage, to avoid duplication of bibliometric data across several databases, and to provide a unique view of the world's largest multidisciplinary database and its themes for advancement.

Data collection followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure data integrity and transparency. The four PRISMA phases followed in the study were data identification, data screening, data eligibility, and data inclusion, as shown in Figure 1.

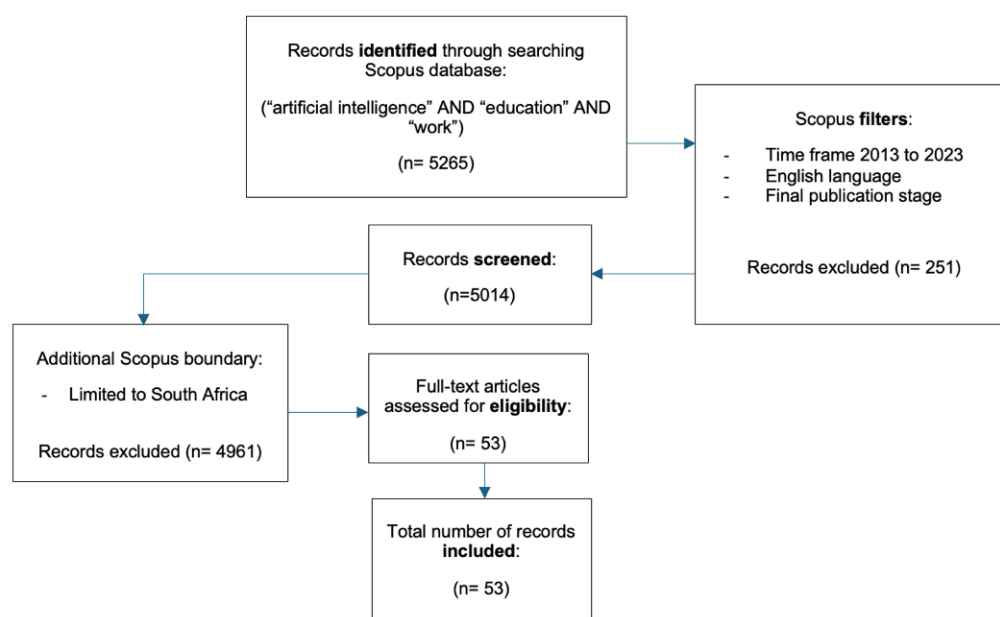


Figure 13: PRISMA Criteria

SOURCE: AUTHORS' COMPILATION

Within the SCOPUS database, all keywords, titles, and abstracts were selected for data searching. Data collection entailed three broad umbrella terms on the SCOPUS database to enhance the number of documents reached: 'artificial intelligence' AND 'education' AND 'work'. The SCOPUS database query consequently comprised: (*TITLE-ABS-KEY ("artificial intelligence") AND TITLE-ABS-KEY (education) AND TITLE-ABS-KEY (work)*). These search terms are unique to this study, with a similar study utilising keywords entailing "Artificial AND Intelligence OR AI AND Education OR Educational, Employability, AI-Driven Skills, College Students" (Fangquan et al., 2024). Additionally, to assess reliability, the selection of keywords used to obtain the data for this study was guided by standard field terms, as shown in Table 1.

As shown in Figure 1, the initial search of the SCOPUS database identified 5,265 documents using the specified terms. The data inclusion criteria encompassed all English-language documents in the final publication stage. Selecting to include English language documents solely was best suited for this study, as it is the author's home language. Additionally, the final publication stage of the documents was selected to ensure reliable bibliometric data was



collected (Pike-Bowles et al., 2025). A third filter was applied to the documents' timeframe, covering 2013 to 2023. This timeframe was selected as the publications within the SCOPUS database entailing the searched terms 'artificial intelligence' AND 'education' AND 'work' were restricted to the year 2023 at the time of data collection for the study. Consequently, this resulted in a decade of publications for this bibliometric review from 2013 to 2023.

After applying the chosen filters to the SCOPUS database, a total of 5,014 documents were screened, of which 251 documents were excluded from the initial 5,265 due to filter incompatibility. During the screening phase within the SCOPUS database, all documents' keywords and abstracts are reviewed to ensure alignment with the selected keywords and the objective of this study. These 5014 documents, therefore, comprised bibliometric data from a global perspective, including all countries.

As the purpose of the study was to gain a global and South African research trajectory of AI research in education and work, an additional limit was applied to the screened SCOPUS dataset of 5014 documents. The additional filter limited the second dataset to South African publications. Here, a total of 53 publications were eligible for inclusion in the second dataset of this study, focusing on South African documents. A total of 4961 documents were subsequently excluded from the initial screening to efficiently identify the current landscape of AI, education, and work within a South African landscape. The following section explains the data analysis of the two bibliometric datasets obtained from the SCOPUS database.

2.2. Data Analysis

The analytical mapping tool used to visualise and interpret the bibliometric analysis for this study was VOSviewer and Bibliometrix. VOSviewer illustrates connections between items displayed on a map (Williams, 2020). According to Oyewola and Dada (2022), VOSviewer and Bibliometrix are analytical software packages that provide effective scientific maps and summaries of bibliometric data. For this study, VOSviewer was used to analyse the co-occurrence of author keywords and countries with no threshold applied to the data set during analysis. This was practised to ensure consistency across the two bibliometric datasets.

In contrast, Bibliometrix was used to identify affiliations and perform thematic mapping of the two datasets. As identified, two datasets were analysed: one for a global landscape and the other for South Africa. Both datasets were analysed individually to provide a comprehensive view and comparison of the research landscape on AI, education, and work, thereby informing a future research agenda for South African scholars.

3. Results

This section elucidates the findings of this bibliometric analysis. The results are divided into two subsections: a global and a South African outlook.

3.1. Global Outlook

Based on the filters and keywords used in this study, a total of 208 countries were identified in VOSviewer. The results indicated that the United States has the highest number of publications and citations globally on this theme. The United States has 1,315 peer-reviewed published documents and 23,326 citations. The other top-producing countries on this theme are China, India, the United Kingdom, and Germany. According to Mühl and Oliveira (2022), the greater the number of citations within a given country, the more impactful the research is



considered. Based on this, the results indicated that the leading countries with the most significant impact are the United States of America, China, and the United Kingdom, as shown in Figure 2.

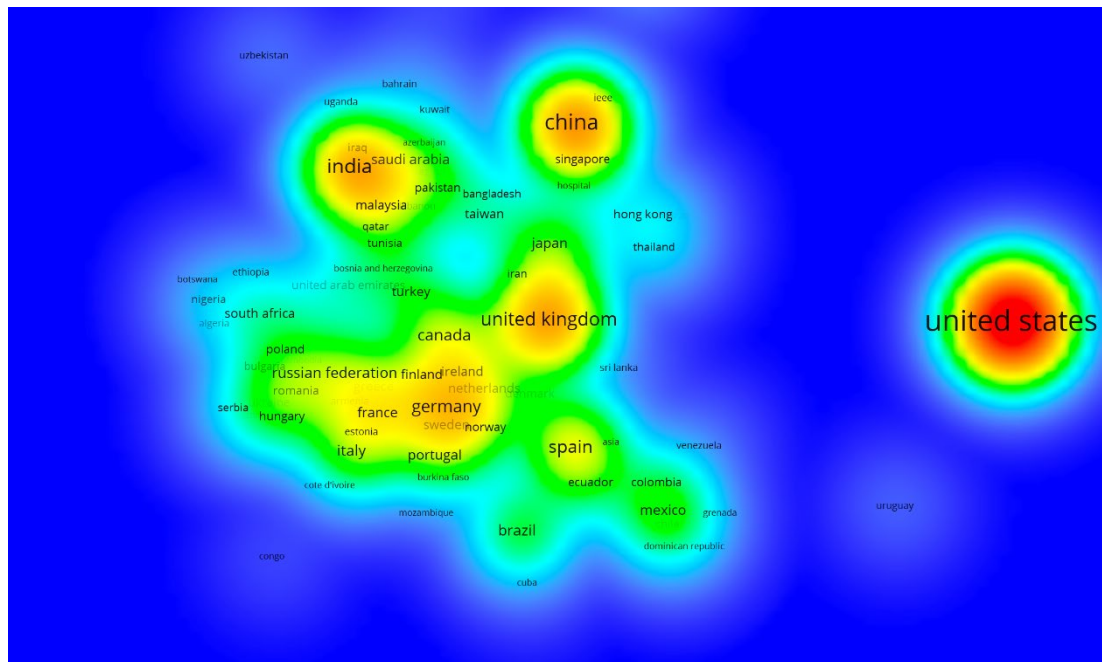


Figure 14: Highest Producing Countries

Source: VOSviewer compilation

The results of this study further highlighted key affiliations associated with publications on this theme. As previously identified, affiliations include the United States of America, the United Kingdom, and China. Table 2 indicates that Carnegie Mellon University currently has the highest number of publications related to its affiliations, with a total of 83 publications to date on this research theme. Additionally, Table 2 illustrates the top three producing countries' commitment to advancing AI across education and work, as indicated by the substantial number of publications associated with each country.

Table 2: Global Publication Affiliations

Affiliations	Number of Published Articles
Carnegie Mellon University	83
Notreported	58
North Carolina State University	46
University College London	42
Nanyang Technology University	36
University of Pennsylvania	32
University of Sharjah	32
University of Southern California	32
Columbia University	30
School of Engineering and Sciences	28

Source: Authors' compilation



Concerning the co-occurrence of authors' keywords, a total of 26,002 keywords were used across the 5,014 documents in dataset one. All keywords were included, and no limitations were applied during data analysis in VOSViewer. The keywords "artificial intelligence," "students," and "learning system" have the highest number of occurrences across the dataset. Education also occurs frequently, but is an older theme. This finding is indicated by the different colour clusters shown in the legend of Figure 3. Therefore, the yellow keyword clusters are recognised as new or emerging themes. In contrast, the purple-coloured cluster node keywords are identified as themes researched in an earlier time frame (Oyewola & Dada, 2022).

Emerging trends gaining traction include "deep learning," "machine learning," "ChatGPT," "chatbots," and "language models." Research involving AI, education, and work began to receive attention in 2022, as indicated by the yellow node clusters. There are also two nodes on 'high education' and 'education'. Interestingly, 'work' and 'employability' are not among the top 50 most frequently used keywords. The low total link strength of the terms 'work' and 'employability' indicates that there has been limited reference to focusing on such a research theme in the working world.

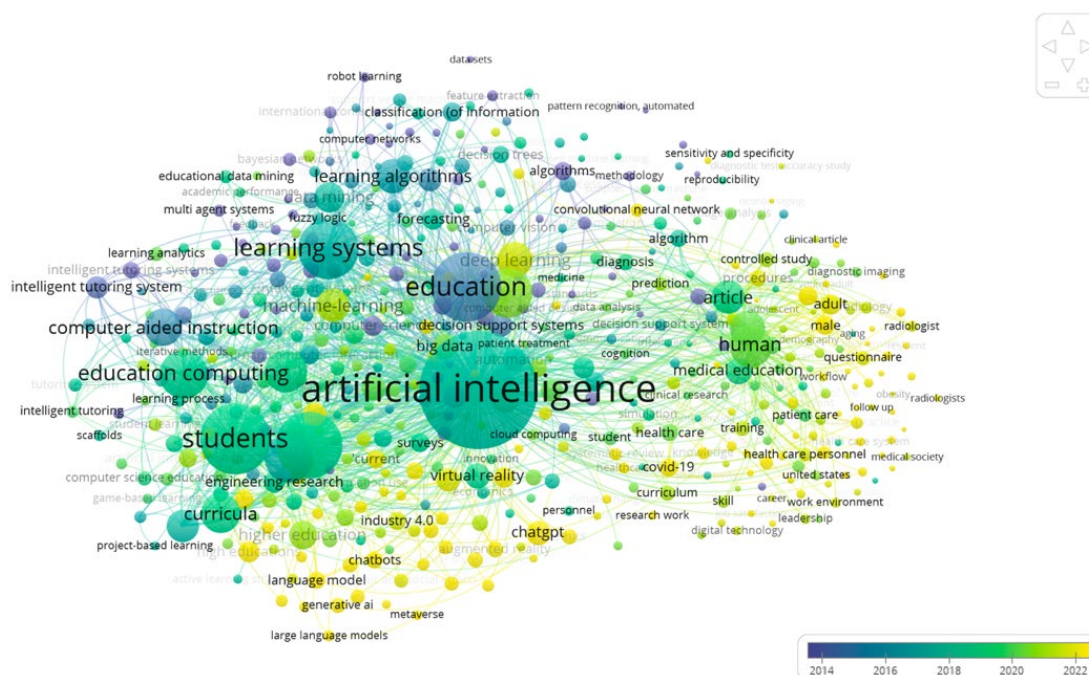


Figure 15: Co-occurrence of Global Keywords

Source: VOSviewer compilation

According to Mühl and Oliveira (2022), motor themes are recognised as essential themes, while niche themes relate to the specialised field of themes associated with a particular topic. Moreover, basic themes are identified as sufficiently developed in the research field, while emerging or declining themes are those with minimal representation in the dataset. Based on



these terminologies, Figure 4 highlights machine learning and deep learning as fundamental themes, while active learning and collaborative learning are emerging themes.

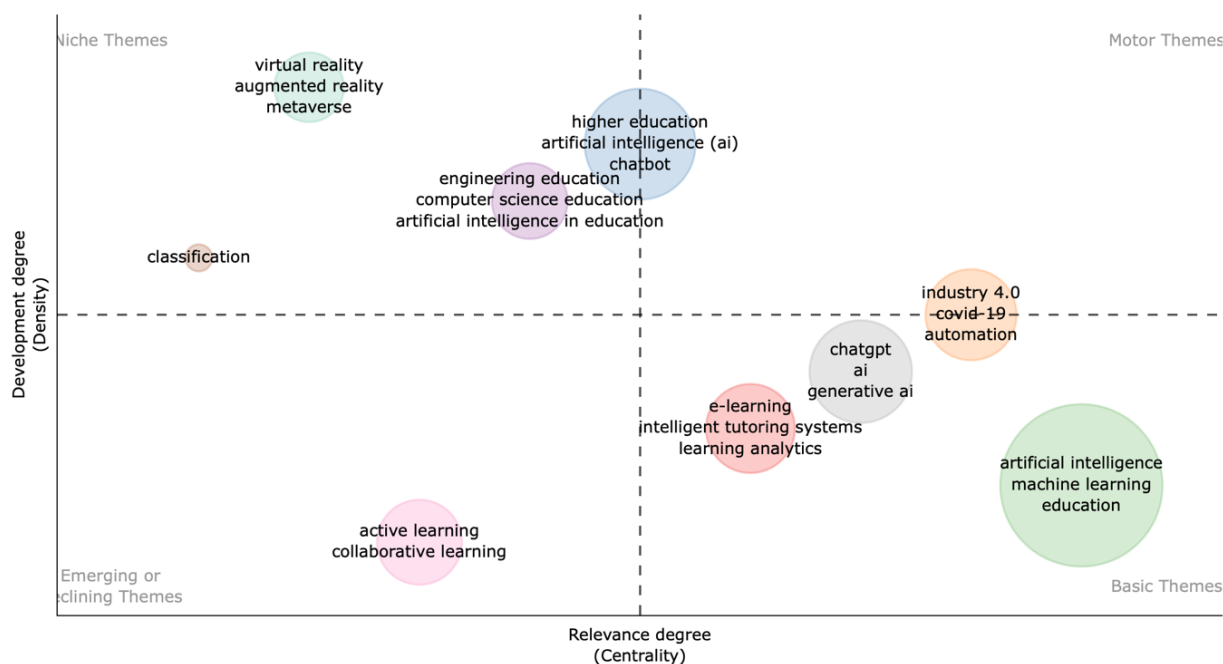


Figure 16: Thematic Map of Global Keywords

Source: VOSviewer compilation

A specialised area of research pertains to virtual reality, augmented reality, and the metaverse. The results in Figure 4 further indicate that research themes such as education, artificial intelligence, and chatbots are shifting from the niche category into the motor division. Moreover, there has been an increased focus on e-learning, intelligent tutoring systems, and learning analytics, as the themes have shifted from emerging divisions to more fundamental ones.

3.2. South African Landscape

As shown in the PRISMA criteria in Figure 1, the South African dataset yielded 53 publications on AI, education, and work, compared with the global dataset, which comprised 5,014 documents. The research findings revealed that South Africa is not listed among the top 10 countries in terms of the number of documents produced and the citations of peer-reviewed publications on this theme. South Africa has 53 peer-reviewed publications, totalling 568 citations on this theme. Compared to the global analysis, South Africa entails fewer keywords across the 53 documents. The results indicate that research has only recently received attention in South Africa.

The top keywords linked to AI, education, and work in South Africa are engineering education, learning systems, human, and students, as seen in Figure 5. Key principles in 2023 included ChatGPT, knowledge construction, awareness, the Internet of Things, digital transformation, and adaptive systems. The top nodes in 2024 were Enabler, AI in education, AI algorithm, activity theory, 5G mobile communication system, and human-machine.

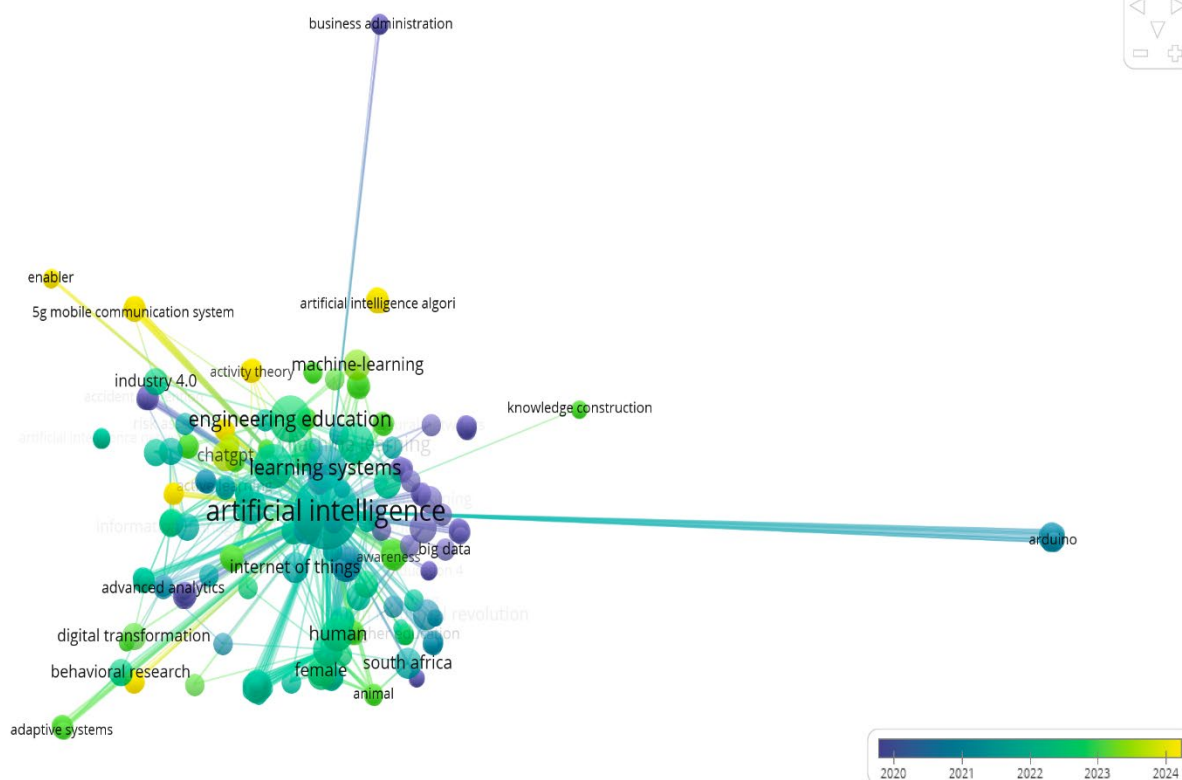


Figure 17: Co-occurrence of Keywords in South Africa

Source: VOSviewer compilation

The results further categorised the niche, motor, basic, and emerging or declining themes related to AI, education, and work in South Africa-specific research as listed on the SCOPUS database. Figure 6 confirms that ChatGPT and artificial intelligence tools are emerging research themes. In contrast, artificial intelligence, engineering education, and learning systems are popular focus areas listed in the motor theme category. Moreover, machine learning, education, and deep learning are receiving increased attention as the topics move from the basic theme category to the motor theme division.

Figure 6 further illustrates the inclusion of themes such as risk management, project management, and Industry 4.0 as emerging research areas, which, in comparison, are not reflected in the global outlook dataset. A comparison between the global outlook and the South African landscape of AI, education, and work indicates that both datasets have focused on machine learning, with ChatGPT emerging as a recent theme in South Africa. However, on a global scale, such themes have received heightened attention. The thematic map of South African themes related to AI, education, and work reveals numerous research gaps across disciplines, as illustrated in Figure 6, which primarily highlights emerging and niche themes in this area.

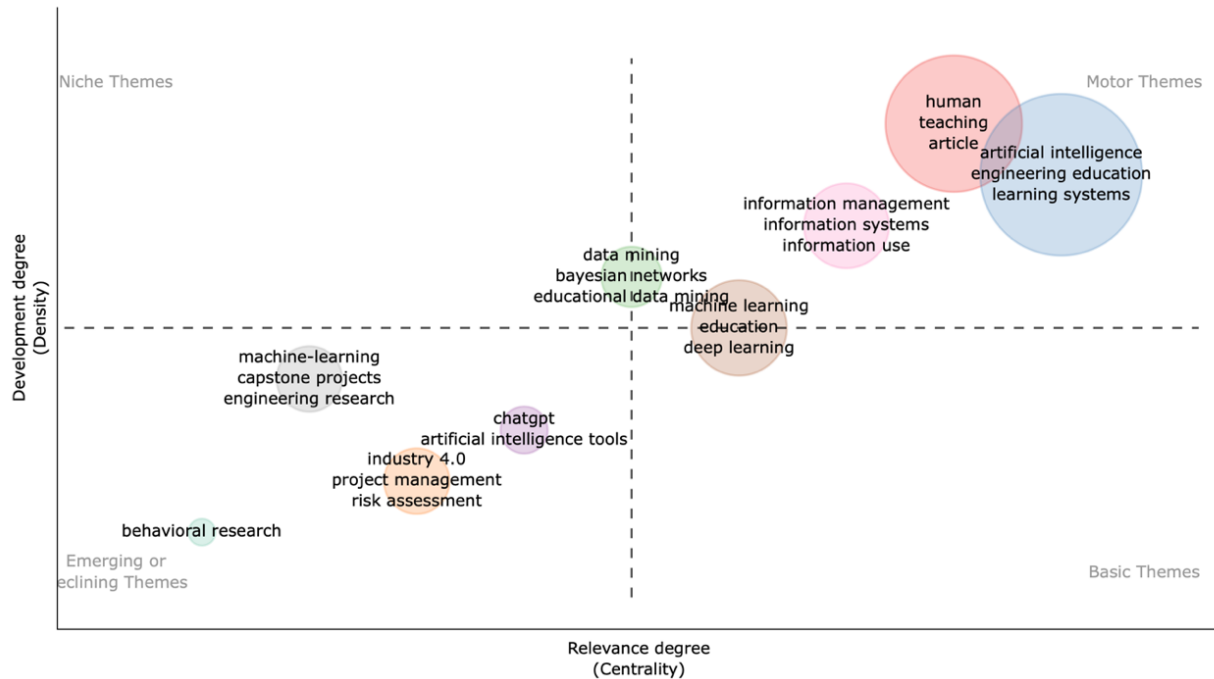


Figure 18: Thematic Map of South African Themes

SOURCE: VOSVIEWER COMPILATION

Based on 53 publications on South African AI, education, and work, the top-producing affiliations are the University of Cape Town (9 publications) and the University of Johannesburg (7 publications). Additionally, Table 3 illustrates international affiliations with South Africa. Such publication affiliations entail the Smart Learning Institute of Beijing Normal University, the University of London, and Uttaranchal University. Interestingly, these affiliations are both local to South Africa and comprise international affiliations (due to author collaborations).

Table 3: South African Publication Affiliations

Affiliations	Number of Published Articles
University of Cape Town	9
University of Johannesburg	7
Smart Learning Institute of Beijing Normal University	6
Nelson Mandela University	5
University of London	5
University of Pretoria	5
Stellenbosch University	4
University of South Africa	4
University of the Witwatersrand	3
Uttaranchal University	3

Source: Authors' compilation



Compared with the global affiliation output of documents, the number of publications listed in Table 3 is much lower. This research finding demonstrates that artificial intelligence research within an education and work focus has recently begun to evolve, with limited scholars from South African affiliations investigating this theme.

Consequently, this study demonstrates a theoretical contribution by determining the research trajectory in the integration of AI, education, and work studies, which indicates several research gaps.

4. Discussion

The results of this study provide a clear visualisation of the current landscape of AI, education, and work globally, with a specific focus on South Africa. The bibliometric analysis indicates that this theme has received heightened attention in leading countries such as the United States of America, the United Kingdom, and China. However, the research theme receives insufficient recognition within the South African landscape. This finding is validated by Bhana et al. (2023); however, their study focused on the inclusion of AI within an accounting curriculum at one university in Durban, South Africa. Moreso, Seshoka et al. (2023) argued that the university curriculum modules do not incorporate the required skills for effective AI use. However, their study was further conducted, focusing on one university in Johannesburg, South Africa.

A similar bibliometric analysis to this investigation is that of Evwiekpaefe and Tohomdet (2024), who argued that AI applications are essential to university admissions processes. Key research themes that have received insufficient attention must be investigated to improve the quality of education offered in South African educational institutions, as is the case in First-World countries such as the United States, the United Kingdom, and China. This study identified a new area of focus: applying AI tools and algorithms to the education sector of higher institutions.

According to Wahab et al. (2024) and Verma et al. (2024), the employability and educational landscape requires ethical considerations when implementing AI transformations. However, this keyword was not reflected in either the global or South African dataset visualisations for the AI, education, and work theme. This indicates a gap for future research.

If implemented effectively, the South African education domain has the potential to produce employable graduates by embracing industrialisation within university curricula (Evwiekpaefe & Tohomdet, 2024; Hlongwane et al., 2024). With a focus on South Africa, the results further indicate an affiliation gap, with academic institutions, including the University of Fort Hare and the University of Rhodes, not currently affiliated with high-end publications in AI, education, and work. This indicates new insights into the landscape of affiliations that require acknowledgement by scholars across South Africa.

According to Hlongwane et al. (2024), educators in Zimbabwe are hesitant to embrace AI in teaching and learning, fearing job replacement. The bibliometric results of this study align with Hlongwane et al.'s (2024) argument, focusing on machine learning and human teaching as key factors for enriching our understanding of these practices. Although this study's findings support those of Hlongwane et al. (2024), it offers a new insight: it pertains to South Africa,



whereas Hlongwane et al. (2024) had a distinct focus on Zimbabwe. Thus, a collaboration and replication of such a study should be conducted within the South African borders.

5. Managerial Implications

This study makes a theoretical contribution to the educational field by providing a unique bibliometric analysis and outlining a future research agenda. Acknowledging the current research outlook raises implications for scholars and research funding institutions. These results should serve as key decision-making criteria for research institutions to align their research calls with AI and enhance employability through education. Education policymakers and educators must rethink their strategies and gain new insights into the challenges students face to enhance graduate employability.

Consequently, the results of this study contribute to the existing literature landscape by highlighting key research themes that require attention within the AI and employability focus, both globally and in South Africa. Educational institutions that consider these findings will benefit by conducting influential research studies on the suggested research themes to improve curricula, foster graduate employability, and enhance understanding of such systems within the education field.

A comprehensive overview of the research on artificial intelligence and employability was identified through the keywords "AI," "education," and "work." New insights and recommendations are made to aid the development of such literature within a South African context. The low total link strength of the terms 'work' and 'employability' indicates that there has been limited reference to focusing on such a research theme in the working world. Increased research attention is required on AI, education, and work to help lower high graduate unemployment levels.

Additionally, future research should not be conducted in isolation, and collaborations should be encouraged at both global and South African levels to gain new insights and reformulate the current education framework with AI in South Africa. The results of this study identify various research avenues to be explored, both qualitatively and quantitatively, based on the emerging themes, to minimise the knowledge gap and develop our education curricula to aid graduate employability.

6. Future Research Avenues

Future research themes are provided to South African academics to uncover not only the influence of AI in education but also to identify a framework for managing and ensuring quality education through machine learning. What does the future of education look like? And how will this be achieved? The authors suggest that researchers focus on the following areas in their future research endeavours: AI; work and/or employability; AI in teaching and learning; AI ethical considerations; AI strategies in higher education; and AI and employability skills in South Africa, as illustrated in Figure 7.



Model of Future Research Avenues on AI in South African Education

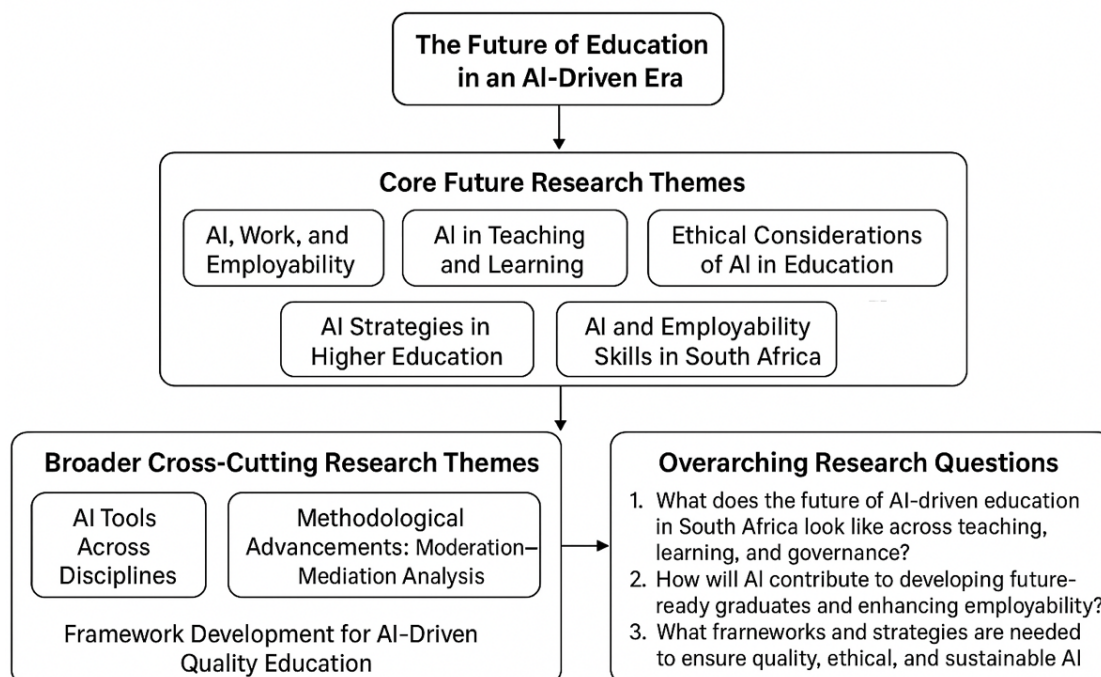


Figure 7: Future Research Avenues

SOURCE: AUTHORS' COMPILATION

Figure 7 presents the suggested future research avenues identified from the gaps highlighted in the research findings. Such future studies are recommended to consider broader AI themes in education in South Africa to gain a comprehensive understanding of AI's effects on education and graduates' employability. Thus, future research studies are also encouraged to employ moderation-mediation analysis to advance knowledge through methodological contributions on how these variables influence one another in the educational domain.

Moreover, future research avenues are encouraged to focus across all disciplines to advance the AI research landscape and determine the various tools being utilised in education and the workplace. Thus, interdisciplinary research is recommended, for example, with scholars specialising in information technology, psychology, and business management collaborating to determine ethical governance for regulating AI within educational institutions.

By addressing the suggested research avenues, scholars will not only advance the academic field of South Africa but also enhance skills development in AI and prepare learners effectively for industry readiness in a developing economy with high unemployment rates.

7. Delimitations

This bibliometric analysis encompassed three boundaries set by the researchers. The delimitations align with the SCOPUS database filters, as previously illustrated in Figure 1. Secondly, this study only considered studies in the final stage of publication, excluding those in the review stage of publication, to enhance data reliability. The third delimitation was to collect data from a single database (i.e., SCOPUS) to reduce data duplication and ensure transparency in the current landscape of AI, education, and work. Additionally, to provide specific insight into the research on this theme within the SCOPUS database.



These three delimitations should be considered for future research studies to probe research authenticity further. In contrast, the following section discusses the limitations of the study.

8. Limitations

Limitations occur in all research studies and are recognised as constraints beyond the researchers' control (Shah et al., 2024). This bibliometric analysis was constrained by three key limitations. The first limitation noted is the timeframe of this study's execution. Although the bibliometric dataset includes existing literature on such a theme, due to the rapidly evolving AI domain, new research publications may not have been captured in this bibliometric analysis review at the time of publication. Secondly, the study employed a bibliometric analysis that did not account for the ethical considerations of AI use in the educational domain, as the umbrella term 'education' was used to provide a broad overview of the research landscape.

The third limitation comprised researcher bias. Here, the selected keywords and interpretations of the study may not adequately reflect the research trajectory of AI within the education and employment field as set by the researchers. Moreover, language bias was noted, as the filters applied to the SCOPUS database search included only English-language documents, the researchers' home language (Dagli et al., 2025). Subsequently, future research is encouraged to consider these limitations as additional avenues for exploration and study significance.

9. Conclusion

The bibliometric analysis successfully achieved its objectives, providing an overview of the current research landscape, both globally and locally. Globally, there has been a focus on AI, students, and learning systems due to the availability of resources in developed countries. Attention must be paid to South Africa and developing economies to align with the rest of the world and advance the country's growing economy through AI in education. Numerous research gaps exist within a South African context.

Academics are encouraged to explore the suggested research avenues to advance the body of knowledge in South Africa, aligning the education curriculum with the Fourth Industrial Revolution to enhance the nation's graduate employability rate. Consequently, the authors argue that the research landscape on AI and the labour market within education requires future research enquiries, as identified in the results of this bibliometric analysis.



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Exploring The Impact of Erosion of Critical Thinking on Academic Integrity in the Context of Student Over-Reliance on AI Within Gauteng University

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Abstract

The rapid integration of AI tools in higher education, exemplified by recent controversies surrounding ChatGPT, is rapidly changing academic practices in generally resource-constrained contexts, such as those in Gauteng universities in South Africa. This qualitative case study investigates how students' over-reliance on AI-powered writing tools erodes critical thinking and undermines academic integrity to the detriment of sustainable educational development in line with SDG 4: Quality Education. Using self-determination theory, cognitive load theory, theory of planned behaviour, and moral development theory, this study investigates 20 undergraduate and postgraduate students at one Gauteng university through phenomenological semi-structured interviews. Sampling was purposive across diverse faculties to ensure variation in students' engagement with AI. Thematic analysis via Atlas.ti yielded four major themes: (1) cognitive offloading diminishing autonomy and depth of reflection; (2) surface-level engagement reducing the analytical sophistication of tasks; (3) ethical ambiguities surrounding the norm of authorship and plagiarism; and (4) contextual pressures such as workload inequalities that exacerbate vulnerabilities. These findings are supported by empirical literature indicating declines of 15-25% in metacognition and integrity risks due to unguided AI use. In the heterogeneous Gauteng setting, AI cloaks skill deficits but entrenches divides and complicates equitable learning. In a theoretical contribution, this study extends cognitive and ethical frameworks to African digital ecologies, while also recommending practical solutions, including scaffolded AI literacy programs, policy reforms for transparency and disclosure, and assessment redesigns that encourage reflective tasks. These interventions will ensure resilient, ethics-grounded learners for whom AI augments, rather than undermines, sustainable human capital development. By striking a balance between innovation and integrity, universities can achieve SDG 4 targets for inclusive lifelong education in increasingly technologically disrupted settings.

Keywords:

Artificial Intelligence, Academic Integrity, Critical Thinking, Gauteng University, Higher Education, Over-Reliance, Sustainable Development Goal 4.



Introduction

Background

The current integration of artificial intelligence (AI) into higher education has sparked intense debate about its implications for student learning and ethical conduct. Tools such as ChatGPT and other AI-driven writing platforms promise efficiency, yet they also risk reshaping fundamental academic skills in ways that are not fully understood. In particular, the potential erosion of critical thinking and the undermining of academic integrity have become pressing concerns, especially in environments where students exhibit growing over-reliance on AI writing tools (Baker & Smith, 2019; Rudolph et al., 2023). These dynamics raise essential questions about how universities can sustain educational quality while adapting to disruptive technological innovations.

The capacity for critical thinking is often described as the cornerstone of higher education. It involves the ability to question assumptions, evaluate evidence, and generate original insights, skills that underline both academic success and lifelong learning (Facione, 2020; Paul & Elder, 2019). However, reliance on AI tools for generating text may short-circuit these cognitive processes by providing polished answers without requiring deep engagement. While students might perceive this as an aid to efficiency, educators increasingly worry that it fosters surface-level engagement rather than reflective analysis. As such, understanding how students themselves perceive the impact of AI on their critical thinking is central to examining the broader academic implications.

Parallel to this, the construct of academic integrity represents a critical pillar of university culture. Traditionally, it embodies honesty, fairness, trust, and responsibility in academic work (Bretag, 2016; Macfarlane et al., 2014). Yet, AI-generated writing complicates conventional notions of plagiarism and authorship. For instance, when students submit AI-assisted work, the line between legitimate support and academic dishonesty becomes blurred. Early research indicates that many institutions are unprepared for this ethical ambiguity, often relying on detection technologies that lag the rapid evolution of AI tools (Cotton et al., 2023; Eaton, 2021). This tension between technological convenience and ethical responsibility underscores the urgent need for scholarly inquiry into how academic integrity is conceptualised and practised in AI-mediated contexts.

The specific context of student over-reliance on AI writing tools further sharpens this research agenda. In regions such as Gauteng, South Africa, universities face compounded challenges: large student populations, resource inequalities, and systemic pressure to maintain academic standards (Cloete, 2016; Jansen, 2019). In such settings, AI tools may appear as shortcuts to success, masking deeper skill deficits and reinforcing problematic academic behaviours. While policymakers emphasise digital inclusion and innovation, little empirical research has explored how students' overuse of AI technologies intersects with their capacity for critical thinking and adherence to academic integrity norms. This gap leaves institutions ill-equipped to develop nuanced interventions that balance technological opportunities with educational ethics.

By addressing this intersection of critical thinking, academic integrity, and AI over-reliance, the present study contributes to both theory and practice. Theoretically, it extends frameworks such as cognitive load theory, moral development theory, and the theory of planned behaviour to new digital-age challenges. Practically, it generates insights that can inform institutional policies, teaching practices, and ethical guidelines tailored to the South African higher education context. Ultimately, the study aims to illuminate how students negotiate the promises and pitfalls of AI in ways that impact their intellectual growth and ethical decision-making (Amigud & Dawson, 2020; Cotton et al., 2023). In doing so, it addresses an urgent gap at the heart of contemporary higher education: how to sustain rigorous, ethical, and critically engaged learning in an age of intelligent machines.



Problem Statement

AI writing tools are reshaping student authorship around the world, particularly at the university in Gauteng, which is the subject of this study, and they do so rapidly (Jisc, 2023; Woolf, 2022). Students submit text that looks polished yet often lacks analytical depth. The surface is neat; the argument is thin (Xu et al., 2024; Adams & McLaren, 2023). This pattern signals a collapse in the effortful practices that produce scholarly judgment. The phenomenon is simple to describe and damaging in effect: student over-reliance on AI writing tools reduces active engagement with material and substitutes algorithmic output for reflective thought.

The immediate casualty is critical thinking. Self-determination theory explains why: when students relinquish intellectual tasks to external agents, autonomy and intrinsic motivation decline (Deci & Ryan, 2000). Cognitive load theory clarifies the mechanism: offloading cognitive work to an AI eliminates productive struggle and reduces germane processing required for higher-order reasoning (Sweller et al., 2019). Students who depend on shortcuts do not practise analysis; they do not build the mental schemas that sustain critical inquiry. The result is a measurable decline in task complexity and argument sophistication (Xu et al., 2024).

Concurrently, academic integrity erodes. The theory of planned behaviour suggests that attitudes, perceived norms, and perceived control influence choices about AI use; convenience and permissive norms tend to steer behaviour toward unreflected reliance (Ajzen, 1991). Moral development theory reveals a related worry: without structured encounters that require principled judgement, students risk operating at pre-conventional ethical levels where expedience overrides principle (Kohlberg, 1981). Institutions maintain clear rules for human-sourced scholarship, APA and Harvard conventions to mention but a few, but comparable standards for acknowledging AI contribution are absent (Johnson et al., 2023). That absence generates ambiguity about authorship, responsibility, and fairness.

Existing research treats the issue in fragments. Work to date emphasises detection metrics, tool uptake, or techno-policy guidance (Jisc, 2023; Selwyn & Pangrazio, 2024). Little attention has been paid to the lived, interpretive experiences of students who balance efficiency, skill formation, and ethical obligations. The gap is empirical and conceptual. We lack a fine-grained account of how student over-reliance on AI writing tools mediates the relationship between diminished critical thinking and weakened academic integrity within a single institutional setting.

A qualitative case study at Gauteng University will illuminate those processes. Grounded in self-determination theory and cognitive load theory for the cognitive construct, and in the theory of planned behaviour and moral development theory for the ethical construct, the study will reveal how students perceive, rationalise, and negotiate the trade-offs between speed and scholarly responsibility. The findings will not only fill a theoretical blind spot but will also furnish policy-relevant evidence for pedagogies that protect deep thinking and authentic authorship.

Research Objectives

To explore how student over-reliance on AI writing tools affects the interplay between critical thinking and academic integrity in the context of a Gauteng university.

Secondary Objectives

1. To examine how student over-reliance on AI writing tools influences the development and erosion of critical thinking skills within academic contexts at a Gauteng university.



2. To explore how the erosion of critical thinking through student over-reliance on AI writing tools creates emerging risks for academic integrity practices at a Gauteng university.
3. To analyse the ethical tensions between academic integrity and student over-reliance on AI writing tools, focusing on originality, plagiarism, and authorship.

Literature Review

This literature review is divided into three sections: the theoretical framework that underpins the study, a conceptual literature review, and an empirical literature review. It synthesises scholarship from 2019 to 2025, emphasising AI's disruptive effects on critical thinking and academic integrity in higher education, with a focus on gaps in African, particularly South African and Gauteng, contexts.

Theoretical Framework

This study is informed by four interrelated theories that help explain the cognitive and ethical mechanisms underlying AI over-reliance, namely, Self-Determination Theory (SDT), Cognitive Load Theory (CLT), Theory of Planned Behaviour (TPB), and Moral Development Theory (MDT). These frameworks extend traditional educational psychology into AI-mediated learning, addressing how technological shortcuts undermine reflective processes and ethical agency in diverse settings, such as a university in Gauteng.

According to SDT, motivation prospers because of the need for autonomy, competence, and relatedness (Deci & Ryan, 2000). In AI contexts, over-reliance erodes autonomy by externalising intellectual labour and diminishing intrinsic drive toward deep engagement. This is also a concern when using unguided AI, as it diminishes students' sense of mastery, especially in high-pressure settings where the drive for efficiency overrides self-directed inquiry (Ryan & Deci, 2020). Thus, SDT frames AI as a motivator when scaffolded but as a demotivator when there is unchecked reliance, with applications for realising sustainable learner agency in resource-constrained African higher education.

Cognitive Load Theory (CLT) differentiates between three forms of cognitive load: intrinsic load, which stems from the inherent complexity of the subject matter; extraneous load, which arises from poor or ineffective instructional design; and germane load, which supports the development of meaningful mental schemata. While AI tools can reduce extraneous load by accelerating content generation, they may unintentionally hinder germane processing when students rely on them for evaluative or reflective reasoning. This creates a substitute risk, where students, especially novices, become less engaged in critical thinking, potentially leading to cognitive stagnation. Therefore, CLT emphasises the need for instructional strategies that intentionally redirect cognitive effort toward analytical thinking, such as prompting students to refine, critique, or improve AI-generated responses.

TPB models ethical intentions through attitudes, norms, and perceived control. Favourable attitudes toward the convenience of AI, together with permissive peer norms, predict over-reliance and integrity lapses, such as unacknowledged authorship. TPB shows that institutions play a role in shaping perceptions of control through policy, providing a lens for interventions that would normalise ethical use of AI in the heterogeneous student populations in Gauteng.

MDT describes different stages of ethical development from pre-conventional or self-interest to post-conventional or universal principles reasoning. The ethical ambiguities of AI, such as blurred lines of plagiarism, may arrest the development process at expedient stages that prioritise outputs over principled authorship. Finally, MDT, coupled with Ubuntu-inspired African ethics, emphasises the importance of dilemma-based pedagogies in promoting moral cognition to ensure that AI extension upholds and does not supplant integrity.



Put together, these theories lead to a hybrid model wherein cognitive erosion is explained by SDT and CLT, and ethical vulnerabilities by TPB and MDT. In turn, this fills existing gaps in African scholarship, where Western models often fail to consider the socio-cultural influences of AI adoption in setting context-sensitive strategies for sustainable education.

Conceptual Literature Review

Conceptually, AI in higher education encapsulates a tension between augmentation and substitution, which reconstitutes critical thinking as a disciplined process of analysis, evaluation, inference, and explanation, while also upholding academic integrity, defined as adherence to honesty, fairness, and responsibility in scholarly work. The OECD describes AI as machine systems that infer outputs from inputs to influence decisions, yet its generative capabilities in writing, grading, and revision introduce ambiguities: does AI enhance metacognition or foster "cognitive offloading," where deliberate thought yields to algorithmic delegation?

Without scaffolds, critical thinking loses its conceptual interrogating evidence for reasoned arguments reflective judgment may be replaced by polished but unexamined outputs from AI (Zhai & Wibowo, 2024). This plays out in two opposing ways: AI as a pedagogical instrument, improving engagement in output critique tasks (Lee et al., 2025), against AI as a disruptor, allowing "substitution effects" to weaken creativity and originality (Pramjeeth & Ramgovind, 2024). In African contexts, these dynamics lead to decolonial imperatives: AI could democratise access in unequal systems, like Gauteng, but may entrench divides if reliance masks foundational skills, in opposition to ubuntu's ethos of knowledge held in common (Ndlovu, 2022; Le Grange, 2023).

Academic integrity faces parallel conceptual fractures similarly. Generative AI muddies authorship, further complicating plagiarism, as "ghost contributions" evade detection, shifting from deontological rules e.g., APA attribution to consequentialist debates on learning outcomes (Cotton et al., 2023; Eaton, 2021). Divergences frame AI as an inevitable threat, facilitating undetectable dishonesty (Khalil & Er, 2023), or a contingent opportunity, enhanced by transparent policies that foster feedback literacy (Kasneci et al., 2023). Perceptions reveal misalignment: students view AI as legitimate aid, while institutions emphasise authenticity, exposing pre-existing pedagogical gaps (Perkins, 2023).

These tensions are accentuated by policy and regulation. Coherent frameworks that balance oversight with autonomy are called for, but proliferation outpaces development, yielding reactive guidelines that either normalise misuse or stifle innovation. The conceptual debates polarise between restrictive deterrence, for instance, AI-resistant assessments, and integrative literacy that embeds reflective practice. In the Gauteng landscape, resource disparities and cultural norms raise questions about universality: How do inequities influence policy efficacy, and does AI expose or erode ethical reasoning?

This review identifies an intermediary conceptual model: AI over-reliance → critical thinking erosion → integrity threats modulated by policy. Gaps persist in socio-cultural conceptualisations in African universities on how AI must align with the equity pillars of sustainable development.

Empirical Literature Review

Empirical studies from 2023 to 2025 confirm AI's dual-edged impact; emerging African data highlights the risks of over-reliance on both critical thinking and integrity, although evidence for Gauteng remains sparse.



On the erosion of critical thinking, Gerlich's mixed-methods analysis (2025, n = 400, ages 17-25 years) linked frequent reliance on AI to lessened skills due to offloading. Youth were more dependent and reasoned more poorly than experienced students. In support, the systematic review by Zhai and Wibowo (2024) with 50 studies showed that over-reliance on dialogue systems undermined decision-making and reflective processes. Over-reliance thus correlated with declines in metacognition of 15-25%. Conversely, Lee et al. (2025) posit that reflective integrations, such as prompt evaluation, enhance engagement by 12%. Equally, the qualitative South African study of Pramjeeth and Ramgovind (2024) with n=300 participants has shown how substitution weakens argument construction across diverse faculties. This deficit further resonates in the findings of a 2025 systematic review, focusing on over-reliance hindering motivation to self-reflect. Interventions are varied: scaffolded use encourages depth, according to Akbar (2025), versus assessments resistant to AI for authenticity. Gaps in Africa include a few that probe socio-cultural shaping; for example, in Gauteng, longitudinal tracking of normalisation is rare (Zhai & Wibowo, 2024).

Cotton et al. (2023) found in a survey of 1,200 students that AI shortcuts increased plagiarism risks by 18%, with ambiguous authorship eroding judgment. Foltynnek et al. (2023) analysed policies across 50 institutions, noting how reactive vagueness left faculty enforcing inconsistently, which normalised misconduct. An experiment by Khalil and Er (2023, n=150) confirmed the challenges of detecting AI, while Kasneci et al. (2023) found that scaffolded policies increased ethical competencies among participants. Perceptions are misaligned: Perkins (2023) found that students framed AI as a form of support, rather than cheating, while institutions had concerns about authenticity. South African evidence: Mlambo (2024) warned of stifling creativity in higher education due to over-reliance on AI. A 2025 ODeL study (n=250) explored integrity challenges and advocated for the promotion of ethical behavior. Ethical tensions remain, with questions about whether AI exposes design flaws (Cotton et al., 2023).

Policy responses are contested: Foltynnek et al. (2023) documented interim guidelines that risk eroding trust, while Cotton et al. (2023) proposed governance measures to shift norms. Restrictive versus adaptive approaches divide deterrence via sanctions (Khalil & Er, 2023) versus literacy curricula (Kasneci et al., 2023). International initiatives abound, but evidence in Gauteng lags behind in implementation amid disparities (Perkins, 2023). A 2025 South African review highlighted the use of ChatGPT in learning and called for balanced policies. Tensions balance accountability and autonomy, with overly prescriptive rules yielding compliance without comprehension.

In Consensus, transformative impact is achieved through threat-opportunity divergence, yet there is silence on longitudinal, context-specific data, particularly regarding South African intersections with classroom practice.

Research Design and Methodology

Research Paradigm and Design

This study is grounded in the interpretivist paradigm, which seeks to understand the subjective meanings and lived experiences of participants within their natural contexts. The interpretivist position is particularly appropriate for this research because it seeks to uncover how students personally experience and make sense of AI tool use, critical thinking processes, and academic integrity dilemmas-phenomena that are deeply embedded in individual perception and institutional context.

In this regard, the study employs a qualitative case study design in conjunction with phenomenological approaches. The case study offers an in-depth understanding of complex, context-bound phenomena within a bounded system, specifically a university in Gauteng, and considers institutional, cultural, and technological factors that shape students' experiences (Yin, 2018). To complement this, phenomenology focuses on the lived experiences of



participants, revealing how over-reliance on AI writing tools influences cognitive engagement, ethical reasoning, and decision-making processes (Creswell & Poth, 2018).

Creswell & Poth (2018) posit that the integrated design is particularly appropriate for exploratory research into relatively understudied phenomena. It allows not only for the identification of observable behavioural patterns but also for an interpretation of the subjective meanings students attach to AI-assisted academic practices. Combining insights with contextual richness and phenomenological depth, this study aims to illuminate the behavioural trends and their deeper, embedded perceptual mechanisms, providing a nuanced understanding crucial for policy, pedagogy, and ethics governance in AI-mediated higher education.

Research Approach

This study employs a qualitative research design primarily because it facilitates the elicitation of rich, contextualised insights into complex human experiences and social processes that cannot be captured through numerical measurement alone (Braun & Clarke, 2021). It is concerned with subjective phenomena-things such as how students perceive AI's influence on their thinking, how they account for drawing ethical boundaries, and how institutional pressures shape their practice-a qualitative approach is both apt and required. The qualitative approach enables a flexible and iterative exploration of emergent themes and contradictions within participants' accounts. Unlike quantitative methods, which measure the frequency or correlation of AI use, this approach illuminates the how and why behind student behaviours, uncovering the cognitive, ethical, and contextual dimensions that statistical analysis would obscure. The approach also aligns with the study's interpretivist paradigm, which privileges depth and meaning-making over breadth and generalisability.

Research Method

Semi-structured interviews, supported by field notes, are the primary method of data collection. Semi-structured interviews are particularly applicable for exploring participants' subjective experiences and perceptions about AI use, critical thinking, and academic integrity (Braun & Clarke, 2021; Kallio et al., 2016). This method strikes a balance between structure and flexibility: the interview guide ensures that key constructs are systematically explored across all participants, while open-ended questioning and follow-up probes allow participants to articulate experiences in their own terms and reveal unanticipated dimensions of the phenomenon.

Accordingly, interviews were conducted face-to-face and via secure online platforms, such as Teams, lasting 45–60 minutes, depending on the participant's preference or logistical constraints. This dual approach enabled ease of access and captured a range of experiences, allowing for depth of engagement. Interviewing was also complemented by field notes taken during all face-to-face interactions to record contextual information and nonverbal communication, thereby adding depth to the interpretations of data (Patton, 2015).

The application of semi-structured interviews rather than structured surveys or quantitative instruments reflects the interpretive orientation and intent of this study. The former would have limited participants to predefined response categories, running the risk of missing rich understandings of ethical reasoning or context-specific pressures shaping reliance on AI. Unstructured interviews may not provide the systematic focus required to ensure comparability in participant statements and compatibility of the material gathered with research goals.



The rigour was ensured as the interview guide was first piloted with two additional students beyond the main sample, allowing for the development of question clarity and flow. Saturation was checked throughout data collection; interviews stopped when no new themes emerged. This iterative, responsive approach allowed this study to maximise its capacity to generate authentic insight that was grounded in participants' experiences.

Population and Sample

The study was conducted with undergraduate and postgraduate students at a Gauteng university who regularly use AI writing tools in their academic work. The population included students from various disciplines, which allows the research to capture the complex differences in disciplinary practices, technological access, and exposure to AI-assisted learning. Indeed, the composition of this diversity was deliberate, given that patterns of use of AI and critical thinking may vary significantly across humanities, sciences, and professional programmes.

Purposive sampling was used to select those participants who had direct, relevant experience of AI use, in order to align with the research objectives on critical thinking and academic integrity. According to Patton (2015), purposive sampling is justified in qualitative research where statistical representativeness is not a primary goal, but rather the aim is to gather information-rich cases that illuminate the phenomenon under investigation. Participants were recruited from university email lists and student associations; self-selection ensured that students participated only if they had a meaningful engagement with AI.

Although the target sample size was 25 students, saturation was reached at 20 participants; beyond this number, no new information emerged from further interviews. This sample size is consistent with both phenomenological and case study methodologies and has been determined to be sufficient for obtaining depth and thematic richness (Creswell & Poth, 2018; Guest, Bunce, & Johnson, 2006). Stopping at 20 participants reflects methodological responsiveness: going beyond saturation would have been redundant and inefficient, yet the dataset derived was robust enough to substantiate trustworthy findings.

Research Instrument

The primary research instrument was a semi-structured interview guide, prepared with the research objectives in mind. It was organised around three key constructs: critical thinking, academic integrity, and student over-reliance on AI writing tools. The questions were open-ended, inviting participants to articulate perceptions, decision-making processes, and ethical reasoning. Follow-up probes explored integrative experiences, enabling participants to reflect on how AI use influenced their academic behaviour and cognitive engagement. For example, if a participant described using AI for summarisation, the interviewer would probe: Can you describe a specific instance where you felt this shifted your understanding or reasoning process?

This interview was first pre-tested on two students from outside the main sample to assess clarity, question flow, and comprehensibility. Based on feedback from this pilot, some minor refinements were made to the wording and sequencing of the questions to ensure they were culturally appropriate and accessible across various academic levels and disciplines.

Apart from the interview guide, field notes were used as another tool. The researcher took down contextual observations during in-person interviews, including nonverbal cues such as hesitations or emphasis, as well as environmental variables that could provide additional contextual information. These enriched the data with elements that were not captured by the audio transcripts.



Data Collection

Data analysis followed a systematic, iterative process grounded in the study's case study and phenomenological design. All interview transcripts were imported into Atlas.ti to enable rigorous qualitative management and coding. Analysis began with open coding, where line-by-line examination of transcripts captured emergent concepts related to critical thinking, academic integrity, and AI use. Codes were assigned descriptively and interpretively, ensuring alignment with both the participants' language and the study's theoretical constructs (Braun & Clarke, 2021; Creswell & Poth, 2018).

Next, axial coding was employed to categorise codes into broader families, mapping relationships between constructs. For example, codes reflecting diminished analytical reasoning, reliance on AI-generated suggestions, and reduced reflective practices were grouped under the category of "critical thinking erosion." Similarly, instances of plagiarism, authorship ambiguity, and uncertainty in referencing were clustered under "academic integrity vulnerabilities." These categories were then cross-referenced with the participant's context, reflecting the case study's emphasis on bounded contextual understanding (Yin, 2018).

Subsequently, thematic analysis was conducted to identify patterns, contradictions, and interdependencies across the dataset. Themes were iteratively refined using Atlas.ti's visualisation tools, such as network diagrams, illuminated links between habitual AI reliance, cognitive offloading, and ethical decision-making. Themes were then theorised considering phenomenology, interpreting participants' lived experiences to generate insights into how AI-mediated practices reshape cognitive and moral processes.

Throughout the process, trustworthiness measures were applied. Triangulation was achieved by comparing interview data with field notes and institutional policy documents. Member checking ensured credibility, with preliminary themes verified by participants. Reflexivity was maintained through the researcher's analytic memos, documenting assumptions and interpretations to reduce bias (Finlay, 2002).

Ethical Considerations

Ethical adherence was central to this study and guided every stage of the research process. All participants provided informed consent, which outlined the purpose of the project, the voluntary nature of involvement, and their right to withdraw at any point without consequence. Confidentiality was preserved through pseudonyms, and all transcripts and digital material were secured on devices protected by strong passwords. Interviews were held in comfortable and neutral locations, ensuring that no participant experienced pressure, undue influence, or discomfort. Particular attention was given to cultural considerations, disciplinary differences, and the academic contexts in which participants operated. Ethical reflection also extended to possible emotional or psychological concerns, with care taken to ensure that no participant felt judged for their engagement with AI tools. The study followed widely recognised standards for responsible research practice. These safeguards collectively protected participant dignity and allowed a focused exploration of how dependence on AI may shape critical thinking and academic judgment.

Results and Findings

The findings are based on interviews with 20 students from a Gauteng University, where thematic saturation was reached. Analysis was guided by three secondary objectives, each of which directly informed the thematic organisation of the results. The themes capture how students experience academic pressures, shifts in critical thinking, interpretations of academic integrity, patterns of AI reliance, and the risks that emerge when these domains intersect. What follows is a narrative presentation of these themes, illustrated with participant voices that reveal the nuanced ways over-reliance on AI reshapes reasoning, originality, and ethical conduct.



Theme 1: Academic Pressures and Coping Strategies

(Aligned with Objective 1: To examine how student over-reliance on AI writing tools influences the development and erosion of critical thinking skills.)

Students described academic life as a demanding environment that encouraged shortcuts. Postgraduates noted the strain of balancing work, family responsibilities, and coursework, while undergraduates highlighted expectations to produce originality and navigate limited supervision. Participant 8, Undergraduate, reflected: *“Deadlines come all at once, and it feels impossible to keep up. AI becomes a tool to survive, not to learn.”* Participant 19, Master’s, added: *“The pressure to produce something original is constant, but often you just need something polished. AI fills that gap, though it means you skip the deep thinking.”* These pressures created conditions where AI was perceived as less of a threat to integrity and more as a coping device. This finding emphasizes that reliance is often context-driven, stemming from systemic overload rather than individual intent.

Theme 2: Erosion of Critical Thinking

(Aligned with Objective 1: To examine how student over-reliance on AI writing tools influences the development and erosion of critical thinking skills.)

The erosion of critical thinking was consistently raised across participant groups. Undergraduates described avoiding independent reasoning when AI provided fast, polished answers. Participant 3, Undergraduate, explained: *“It’s easier to paste the question into AI because it gives you something clean, even if you don’t fully understand it.”* At the postgraduate level, students reflected on the superficiality of AI-generated content. Participant 13, Master’s, noted: *“It looks academic, but when you read it back, the depth is missing. You don’t have to engage critically, so you stop trying.”* At the doctoral level, the concern was sharper, as Participant 10, PhD, University II, warned: *“If you lean on AI to interpret data, you lose the very skill you’re supposed to be mastering, independent analysis.”* Collectively, these voices show that AI challenges critical thinking by offering shortcuts that replace the intellectual struggle essential for growth.

Theme 3: Institutional Practices and Critical Engagement

(Aligned with Objective 2: To explore how the erosion of critical thinking through student over-reliance on AI writing tools creates emerging risks for academic integrity practices.)

Institutional teaching, research and assessment practices were described as shaping whether students engaged critically or relied on AI. Rigid marking schemes and memorisation-focused assessments were seen as reinforcing dependency. Participant 11, Undergraduate, shared: *“If you give a new perspective, you risk losing marks. The safe option is to let AI phrase it in a standard way.”* In contrast, postgraduate students valued spaces that forced authentic reasoning. Participant 16, PhD, stated: *“A proposal defence doesn’t allow shortcuts. You have to defend your work in real time, and that builds genuine critical skills.”* These insights suggest that reliance on AI is not only a matter of individual choice but also a reflection of institutional environments that either encourage or discourage intellectual risk-taking.

Theme 4: Interpretations of Academic Integrity

(Aligned with Objective 3: To analyse the ethical tensions between academic integrity and student over-reliance on AI writing tools, focusing on originality, plagiarism, and authorship.)

Students’ interpretations of academic integrity varied widely. Many undergraduates equated integrity with compliance, often reducing it to avoiding plagiarism software detection.



Participant 7, Undergraduate, said: *"Integrity just means making sure the similarity score is low. That's how we see it."* Postgraduates expressed slightly different understandings but still treated integrity as largely procedural. Participant 16, Master's, reflected: *"It's about originality, but practically it's about checking the percentage. If it's below the threshold, you're fine."* By contrast, doctoral students described integrity in more philosophical terms. Participant 20, PhD, University IV, noted: *"Integrity is honesty in thought, not just in citation. If AI is doing the reasoning, even correct referencing doesn't make it ethical."* These patterns show that AI complicates the ethical terrain by exposing gaps between procedural compliance and genuine intellectual honesty.

Theme 5: Patterns of AI Reliance

(Aligned with Objectives 2 and 3: To explore how the erosion of critical thinking through AI over-reliance creates academic integrity risks, and to analyse related ethical tensions.)

Students described diverse ways of using AI, but a shared theme was the gradual drift from supportive to substitutive reliance. Undergraduates admitted to using AI to generate entire responses. Participant 2, Undergraduate, explained: *"I paste the question in and hand in what it gives. Maybe I tweak a sentence or two."* At the postgraduate level, students described using AI for organisation but acknowledged slipping into dependency. Participant 14, Master's, reflected: *"At first, it was just to structure my work, but now I let it expand sections for me. It feels easier, but I know it's not my own thinking."* Doctoral students highlighted risks in interpretive work. Participant 20, PhD, admitted: *"It's tempting to let AI summarise patterns in the data, but then I'm not the one making the interpretations. That blurs authorship and originality."* These practices show how AI reliance escalates, weakening both reasoning and ethical ownership.

Theme 6: AI as Survival Strategy (Emergent Theme)

(Not part of the stated objectives but surfaced across participants.)

An unexpected but important theme was the framing of AI use as a survival tool rather than an academic shortcut. Students often defended reliance not as laziness but as a necessity in contexts of overwhelming workload, limited supervision, and high institutional demands. Participant 13, Undergraduate, noted: *"You're not trying to cheat; you're just trying not to fail when there's too much to do."* Participant 8, PhD, echoed this: *"It's not dishonesty for most of us. It's survival in a system that expects constant output with little support."* This emergent theme complicates the interpretation of AI reliance, reframing it as a systemic issue rooted in institutional pressures rather than purely individual ethical lapses.

Table: Summary of Thematic Findings with Contextual Depth and Rigour

Theme	Linked Objective	Key Findings (Context & Variation)	Trustworthiness & Rigor
1. Academic Pressures and Coping Strategies	Objective 1: To examine how student over-reliance on AI writing tools influences the development and erosion of critical thinking skills.	Undergraduates emphasised balancing jobs and coursework, while postgraduates described pressures of originality and publishing. Some relied on peer support; others leaned on AI. Contradictions emerged: a few students valued stress as motivating, while most saw it as overwhelming.	Findings verified across the university and levels; saturation confirmed at 20 participants; member checking confirmed the accuracy of shared pressures.
2. Erosion of Critical Thinking	Objective 1: To examine how student over-reliance on AI writing tools influences the development and erosion of critical thinking skills.	Undergraduates admitted to avoiding independent reasoning, while doctoral students described risks in data interpretation. Contradictions emerged where a minority of postgraduates said AI encouraged them to question outputs, though most described surface-level engagement.	Thick descriptions supported with verbatim quotes; triangulated with field notes of observed reliance behaviours.
3. Institutional Practices and Critical Engagement	Objective 2: To explore how the erosion of critical thinking through student over-reliance on AI writing tools creates emerging risks for academic integrity practices at a Gauteng university.	Rigid rubrics and memorisation-based exams discouraged originality, while viva defences and seminar-based tasks encouraged deeper reasoning. Variation across universities highlighted inconsistent institutional expectations.	Triangulation with institutional assessment guidelines; coding consistency ensured via Atlas.ti cross-checking.
4. Interpretations of Academic Integrity	Objective 3: To analyse the ethical tensions between academic integrity and student over-reliance on AI writing tools, focusing on originality, plagiarism, and authorship.	Undergraduates equated integrity with plagiarism detection compliance, while postgraduates framed it as originality. PhD candidates expanded integrity to intellectual honesty. Contradictions arose between seeing AI as survival vs. dishonesty.	Member checking confirmed integrity definitions; saturation achieved when no new variations emerged.



5. Patterns of AI Reliance	Objectives 2 & 3: To explore how the erosion of critical thinking creates academic integrity risks (Objective 2) and to analyse related ethical tensions around authorship and originality (Objective 3).	Undergraduates reported direct copying from AI; Master's students described using AI for structure; PhD candidates acknowledged slipping into interpretive reliance. Variation emerged where a minority used AI only for grammar or summarization.	Consistency cross-verified across university faculties; triangulation with the researcher's field notes on observed writing practices.
6. AI as Survival Strategy (Emergent Theme)	Not linked to stated objectives (emergent).	Many students framed AI as necessary for survival, not cheating. Undergraduates stressed workload management, while doctoral students emphasized institutional pressure to publish. Contradictions surfaced: some students admitted guilt, others defended AI use as unavoidable.	



Managerial Implications

The results of the present study have important implications for university management, policy, and educational leaders in their efforts to address AI integration while preserving critical thinking and academic integrity. Managerial implications span three key areas: policy and governance, pedagogical reform, and contextual considerations.

Policy and Governance

University management needs to go beyond such fragmented and reactive approaches towards the use of AI. Coherent, adaptive frameworks are required to balance accountability against autonomy. Overly restrictive bans will merely drive usage underground; permissive approaches normalise uncritical dependence. Instead, transparent governance should emphasise scaffolded integration, reflective engagement, and disclosure.

Institutions should establish policies on disclosure pertaining to the use of AI tools, requiring students to clearly document how and where they used such tools in each work. Disclosure should be normalised, not penalised. For instance, this could involve adding a short statement at the top of any assignment submission: *"I used [Tool Name] for [specific function, e.g., summarising sources, checking grammar]. I have reviewed and modified all outputs for accuracy and originality."* This aligns with the calls from Kasneci et al. (2023) and Khalil and Er (2023) for clarity in specifying what constitutes an acceptable use of AI and the shared responsibility of students and faculty.

Pedagogical Reform

These findings indeed showed that rigid rubrics and memory-based assessments reinforce AI dependency, whereas dialogic tasks spur critical engagement. University management must therefore prioritise assessment redesign with a foreground of process, defence, and reflection.

Practical recommendation: Faculties should move towards process-oriented assessments, where AI-assisted shortcuts are ineffective. For example:

- Oral defences, which require students to articulate and justify their reasoning in real time
- Reflective essay requirements from the students on the critique of outputs provided by AI reason for accepting, modifying, and rejecting suggestions.
- Iterative portfolios of stages of thinking, drafting, and revision in which cognitive engagement is made visible
- In-class writing assignments that minimise reliance on outside tools while still considering authentic problem-solving

These approaches have echoed in the work of Lee et al. (2025), who argue that incorporating reflective evaluation into AI use can augment, rather than erode, metacognition.

Contextual Considerations for a Gauteng university and Beyond

Results have shown that resource disparities and supervision gaps within Higher Education Institutions (HEIs) heighten pressures toward dependence. Managerial strategies should, therefore, be sensitive to context and balance global best practices with locally grounded realities. Policymakers and HEI leaders should champion greater investment in educational infrastructure, faculty hiring, and student support services. Addressing structural inequities and inequalities is as important as the regulation of AI itself. The international partnerships and funding initiatives also need to focus on capacity-building mechanisms at resource-constrained institutions. HEIs are encouraged to do comparative analysis of AI policies and practices amongst themselves,



identifying best practices and adapting them to the local context. HEIs could learn from each other's experiences and challenges in the establishment of AI governance.

The managerial implications thus require integrated action across policy, pedagogy, and contextual reform:

- Policy: Implement disclosure frameworks and adaptive governance committees.
- Pedagogy: Redesign assessments to value process, defence, and reflection; invest in faculty development.
- Context: Adapt strategies to resource realities and advocate systemic investment.

By addressing all three levels simultaneously, HEIs can preserve critical thinking and academic integrity and integrate AI in responsible ways into higher education.

Conclusions and Future Research

This study aims to investigate the impact of overdependence on AI writing tools among students on the interaction between critical thinking and academic integrity at a Gauteng university. Based on interviews with 20 students at varying academic levels, the analysis generated five key themes, aligned with three research objectives, and one emergent theme that together offer a textured understanding of how AI reshapes academic practices.

Students repeatedly framed AI as both a lifeline and a liability: both as a mechanism to cope with overwhelming academic pressures and, at the same time, a source of diminished originality and ethical ambiguity. Three interlocking patterns cutting across themes emerged from the findings:

- Cognitive offloading, in which students displaced analytical effort onto AI systems, is evident across academic levels but evolving from direct copying among undergraduates to interpretive reliance among doctoral students.
- Procedural compliance, with many students interpreting integrity in narrow terms—such as plagiarism detection thresholds—rather than broader intellectual honesty.
- Structural adaptation, where AI use was framed less as deliberate dishonesty and more as a survival strategy in contexts shaped by workload intensity, limited supervision, and uneven institutional policies.

Together, these patterns were used to develop the Adaptive Reliance Framework, which positions AI reliance as an adaptive practice situated at the nexus of individual cognition, institutional structures, and systemic pressures. This framework advances scholarship beyond the binary framing of AI as a threat or a tool, instead offering a dynamic understanding of reliance as contingent, contextual, and structured by structural conditions.

Figure 1: Adaptive Reliance Framework

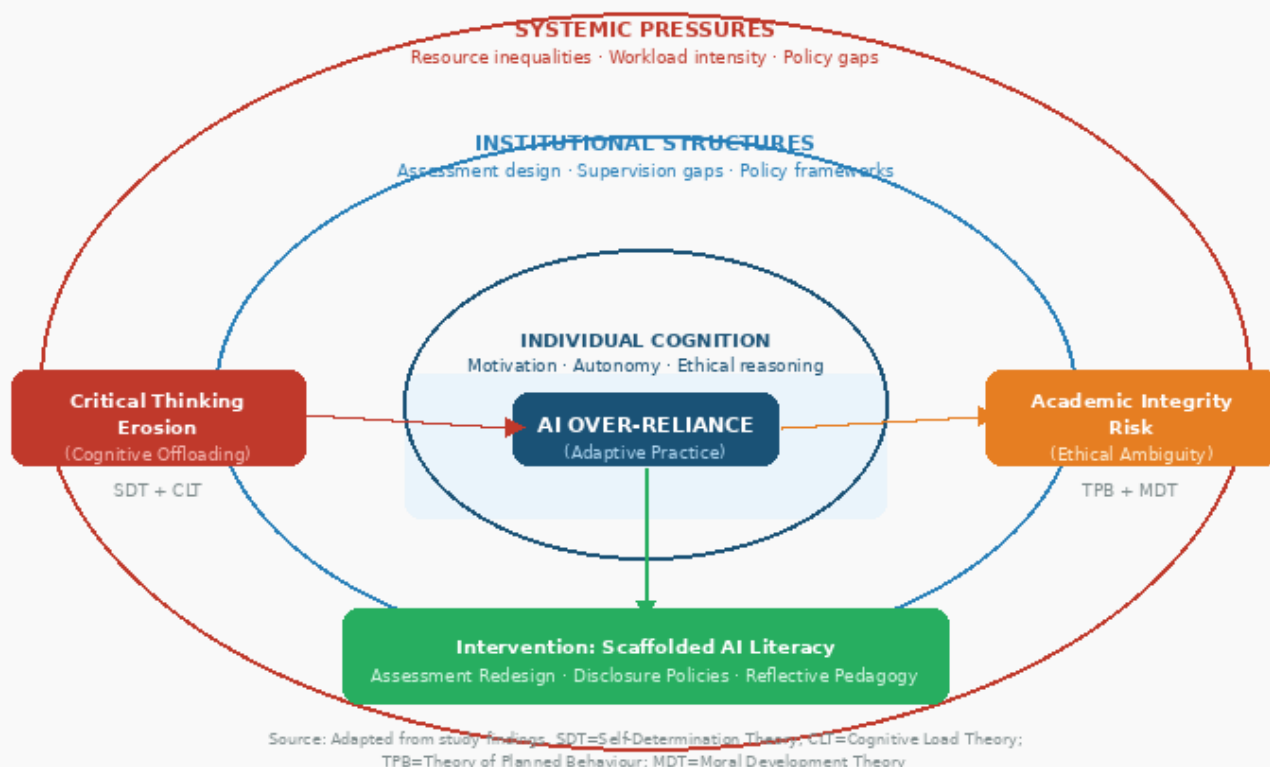


Figure 1: The Adaptive Reliance Framework – positioning AI over-reliance at the nexus of individual cognition, institutional structures, and systemic pressures, with interventions aimed at scaffolded AI literacy.

The study shows that students' reliance on AI cannot be reduced to simple notions of cheating or innovation, but is a complex practice deeply rooted in the pressures, policies, and pedagogies of higher education. Viewed as a structural adaptation rather than an individual failure, reliance reframes the challenge for institutions to move beyond prohibition toward reflective, context-sensitive strategies. By aligning ethical norms, pedagogical reform, and coherent policy, universities in Gauteng and beyond can preserve critical thinking and integrity while responsibly integrating AI into academic life.

Key Contributions

This study makes several contributions to scholarship and practice:

- Theoretical: Introduces the Adaptive Reliance Framework, situating AI use within overlapping cognitive, institutional, and systemic layers
- Empirical: Provides rich, context-specific insights into how students across academic levels experience and rationalise AI use in an African university setting
- Practical: Offers actionable recommendations for policy, pedagogy, and institutional culture that balance innovation with intellectual development
- Ethical: Reframes AI reliance as a structural issue, challenging individualistic narratives of misconduct and calling for systemic reform

Limitations

Like all qualitative investigations, this study is also conditioned by certain limitations. Methodologically, while the purposive sample of 20 students was sufficient to attain thematic



saturation, it necessarily reduced the diversity of perspectives. The sole focus on students means that faculty and institutional voices, which might have shed light on how teaching and policy decisions shape patterns of reliance, are not included.

The research was contextually situated at a Gauteng university, which may not accurately represent conditions elsewhere due to resource disparities, cultural diversity, and institutional variation. The emergent AI theme as a survival strategy may be particularly pronounced in resource-constrained settings, raising questions about its generalisability beyond this context.

Another limitation is subjectivity. In any interpretive analysis, the researcher's decisions in coding and theme development necessarily influence the findings. Reflexive journaling, triangulation, and member checking were employed to address this issue, but the analysis remains interpretive rather than neutral.

Data collection constraints also played a role: while the depth afforded by 45–60 minute interviews, and the inclusion of online sessions to ensure accessibility, some nuances may have been lost compared with exclusively in-person interactions. Finally, the qualitative focus of the study on depth rather than breadth precludes the generalisability of findings in the statistical sense—a deliberate choice to privilege thick description and contextual understanding over representativeness.

Despite these, the veracity of the findings was enhanced by methodological rigour through saturation monitoring, triangulation, and reflexivity to give credence to the findings and their robustness in analysis.

Future Research

Building on these insights, several directions could be pursued in future research:

1. Comparative and Longitudinal Studies

Only comparative studies across regions, cultural contexts, and institutional types can confirm whether this framing of the survival strategy is specific to Gauteng or a broader global phenomenon. Investigating how AI reliance manifests in well-resourced versus under-resourced institutions, or in Western versus non-Western contexts, would illuminate structural dimensions of the Adaptive Reliance Framework.

Longitudinal research would also be valuable, tracing patterns of reliance over time as students progress from undergraduate to postgraduate levels and as AI technologies develop. This kind of work could inform us on how procedural compliance evolves into ethical responsibility or whether reliance deepens as AI becomes increasingly embedded within academic practice.

2. Integrating Multiple Stakeholder Perspectives

Future research should seek to incorporate faculty and institutional input to gain a more comprehensive understanding of the academic ecosystem. For example, exploring how lecturers design assessments, interpret integrity policies, and respond to AI use would reveal the institutional dynamics that shape student practices. Likewise, a comparative analysis of policy implementation across universities could pinpoint effective strategies for navigating the role of AI in higher education.

3. Testing and Refining the Adaptive Reliance Framework

The Adaptive Reliance Framework proposed here offers a way to conceptualise uses of AI as adaptive rather than purely detrimental, situating reliance within overlapping cognitive, institutional, and systemic layers. Empirical validation in varied contexts and disciplines would strengthen its theoretical contribution and ensure its relevance across settings. Quantitative or mixed-methods studies can test the components of this framework and their interactions by examining how cognitive, institutional, and systemic factors independently and jointly predict patterns of AI reliance.



4. Intervention-Based Research

Intervention-based research may consider practical strategies to foster responsible use of AI while preserving critical thinking. Some possibilities include:

- Incorporating reflective critiques of AI outputs into assignments
- Integrating AI-assisted writing with oral defences
- Disclosure statements around AI use

Evidence from such interventions would provide useful insights for HEIs looking to balance AI potential with academic integrity and intellectual development. Experimental or quasi-experimental methods could be used to compare the efficacy of various pedagogical approaches in reducing cognitive offloading and increasing critical involvement.



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Reimagining Hybrid Working and Digital Transformation Adoption as Pathways for Human Capital Sustainability in the Public Sector

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Abstract

The rapid institutionalisation of hybrid working and digital transformation has fundamentally reshaped work design in public sector organisations, yet limited research explains how these changes contribute to human capital sustainability, particularly in developing economy contexts. Drawing on the Job Demands–Resources (JD-R) model and the Technology Acceptance Model (TAM), this qualitative study explores how hybrid working and digital transformation adoption interact to shape employee wellbeing, engagement, and sustainable performance in the South African public sector. A qualitative research design was employed, using semi-structured interviews with nine employees drawn from managerial, professional, and support roles within a national public sector organisation. Participants worked between one and four days per week in a hybrid arrangement. Data were analysed using thematic analysis informed by JD-R and TAM constructs. The findings indicate that hybrid working is largely perceived as effective when it enhances autonomy, flexibility, productivity, and well-being through reduced commuting and fewer workplace disruptions. However, hybrid work also introduces new job demands, including work intensification, blurred work–life boundaries, and coordination challenges. Digital transformation adoption emerges as a critical enabling condition, with technologies such as collaboration platforms and cloud systems improving efficiency and process modernisation when perceived as useful and easy to use. Uneven digital maturity, limited training, connectivity burdens, and misaligned performance management practices constrain sustainability and create equity challenges across organisational units. The study advances a JD-R and TAM framework that conceptualises hybrid working and digital transformation as interdependent pathways to human capital sustainability in the public sector, offering practical implications for HRM and public sector leadership.

Keywords: Hybrid working; digital transformation; human capital sustainability; public sector HRM; Job Demands–Resources model; Technology Acceptance Model

Introduction

The acceleration of hybrid work models and digital transformation projects has profoundly altered how public sector organisations work, manage human resources, and strive for long-term sustainability. Initially a crisis response to the COVID-19 pandemic, hybrid working has evolved into a strategic workforce model, significantly impacting employee wellbeing, productivity, organisational resilience, and the sustainability of human capital systems (Carillo et al., 2021; Vial, 2019). In the public sector, characterised by bureaucratic frameworks, outdated systems, and inflexible employment practices, the adoption of hybrid work models offers revolutionary potential alongside intricate implementation difficulties. In hybrid contexts, digital technologies function not just as operational tools but also as crucial job resources that can alleviate demands and facilitate



engagement, or alternatively, as techno-stressors that intensify strain when inadequately executed. The adoption of digital transformation is crucial for hybrid working and serves as a fundamental means by which public sector organisations may maintain human capital in increasingly volatile, unpredictable, complex, and ambiguous (VUCA) contexts. Digital transformation implicates significant changes in organisational culture, leadership practices, skill requirements, and employee-technology interactions, extending beyond mere process digitisation (Verhoef et al., 2021). Despite swift advancements in the adoption of hybrid work within the public sector worldwide, the current scholarship remains fundamentally fragmented. The existing literature predominantly offers descriptive and quantitative analyses of hybrid work (Bajdor, 2025; Al-Alawi et.al., 2023) yet hardly delineates a mechanism by which digital adoption leads to enduring human-capital outcomes in government. Furthermore, there is a scarcity of qualitative research that elucidates employees lived experiences, sense-making processes, and contextual realities as organisations endeavour to incorporate hybrid working and digital transformation as interrelated avenues for human capital sustainability. This study utilised a qualitative methodology to explore the implementation of hybrid working and the adoption of digital transformation within a specific public sector organisation, as well as the impact of these processes on sustainable human capital outcomes. The study emphasises employee views and organisational behaviours, providing detailed insights into the factors that enable hybrid working and digital transformation to act as complementary drivers of sustainable public-sector success.

Background

Hybrid working arrangements attained a new significance with the emergence of the coronavirus disease (COVID-19) pandemic, when government-imposed lockdowns necessitated organisations to swiftly reorganise work structures to maintain operations and safeguard employee health (Sani & Mandina, 2024). What began as an emergency response has transformed into a fundamental change in the organisation, management, and assessment of work, especially in knowledge-intensive and service-oriented sectors (Wang et al., 2021). Hybrid working was primarily implemented to reduce physical contact, sustain productivity, and alleviate long-term organisational losses amid significant disruptions (Kniffin et al., 2021). The feasibility and effectiveness of such arrangements varied considerably between sectors, occupations, and institutional environments.

The effective implementation of hybrid working demands more than spatial adaptability; it involves intentional organisational and HRM restructuring that harmonises human, digital, and physical aspects of work. From a Human Resource Management perspective, hybrid working transforms job characteristics by modifying task patterns, autonomy, supervisory practices, and performance management systems (Bakker & Demerouti, 2017). The strategic alignment of work processes, leadership behaviours, and digital infrastructure is essential for hybrid work to serve as a sustainable HRM practice instead of a catalyst for work intensification and stress (Wang et al., 2021). Hybrid working has opportunities such as flexibility, autonomy, and enhanced work-life integration, although it also presents issues concerning coordination, availability, oversight, and the preservation of social and professional relationships (Felstead & Reuschke, 2020).

In addition to these advancements, digital transformation is crucial for facilitating and sustaining hybrid working arrangements in both the private and public sectors. In addition to the digitisation of current operations, digital transformation encompasses essential alterations in organisational routines, employee skill demands, leadership methodologies, and employee-technology interactions (Vial, 2019; Verhoef et al., 2021). The rapid advancement of digitalisation has highlighted considerable gaps in organisational preparedness, especially in the public sector, where outdated systems, governance limitations, and a lack of skills persist (Alvarenga et al., 2020;



Mergel et al., 2019). Governments have a specific obligation to promote digital transformation in public institutions to improve service delivery, transparency, and administrative efficiency through efficient information technology governance.

The transition to digitally facilitated hybrid work frequently exacerbates employment demands, especially for employees who possess insufficient digital skills or view new technology as complicated, obtrusive, or incompatible with their job functions. Research regularly indicates that skills deficiencies, technological pressures, and uncertainties related to digital transformation led to employee resistance, disengagement, and diminished well-being (Tarafdar et al., 2019). The opinions of employees regarding digital technologies, specifically their perceived utility and user-friendliness, are essential factors in achieving successful digital transformation and maintaining hybrid work arrangements (Venkatesh & Davis, 2000).

This study argues that the efficacy of hybrid working in the public sector is influenced by employees' perceptions of digital transformation adoption and contextual limitations. This study aims to explore the intricacies of hybrid working and digital transformation, as experienced by public sector employees, using qualitative research. This study enhances the comprehension of hybrid work and addresses the demand for more employee-focused sustainable work practices.

Problem Statement

Digital transformation initiatives have intensified, affecting organisational cultures, rethinking public service delivery methods, and altering connections among public institutions, employees, and citizens. While hybrid working and digital transformation can improve efficiency and service delivery, their success depends on essential enabling factors, including dependable digital infrastructure, managerial support, effective performance management, and ongoing employee skill development (Marozva & Pelsier, 2025; Tarafdar et al., 2019). Without these conditions, hybrid working may increase job expectations, worsen techno-stress, and diminish employee engagement and sustainability instead of improving them. Despite the expanding body of literature on hybrid work and digital transformation, current empirical research is still constrained in several significant aspects. The majority of research has concentrated on private sector organisations and established economies, providing less understanding of public sector situations in developing nations (Kniffin et al., 2021). Secondly, previous research has mostly utilised quantitative methodologies, emphasising organisational-level results like productivity and efficiency, while inadequately exploring employees' lived experiences, perceptions, and sense-making processes. Consequently, this study explores the perceptions of employees in a specific South African public sector department regarding the efficacy of hybrid work models and the implementation of digital transformation. This study utilises a qualitative, employee-focused methodology to produce context-specific insights that inform HRM policy and practice, enhance theoretical development, and deepen the understanding of hybrid working as a means of sustaining human capital in public sector organisations.

Research Objectives

Primary Research Objective

The primary objective of this study is to explore how hybrid working arrangements and digital transformation adoption are experienced and interpreted by employees in a selected South African public sector department, and how these experiences shape the effectiveness and sustainability of hybrid work.



Secondary Research Objectives

- To explore employees' perceptions of digital transformation adoption, including the perceived usefulness, ease of use, and adequacy of digital technologies in supporting hybrid work and service delivery.
- To identify the key challenges and enabling factors associated with the implementation of hybrid working and digital transformation, as perceived by employees, including organisational support, managerial practices, skills development, and infrastructural constraints.
- To analyse how hybrid working and digital transformation interact to influence employee wellbeing, engagement, and sustainable performance within the public sector context.

Literature Review

This section reviews the literature relevant to hybrid working and digital transformation in three interrelated parts. First, it outlines the theoretical framework underpinning the study, drawing on the Job Demands-Resources (JD-R) model and the Technology Acceptance Model (TAM). Second, it presents a conceptual review of hybrid working and digital transformation to clarify key constructs and their evolution. Third, it synthesises empirical evidence on hybrid working and digital transformation, with particular attention to employee perceptions, wellbeing, performance, and public sector contexts.

Theoretical framework

This study draws on the Job Demands–Resources (JD-R) model and the Technology Acceptance Model (TAM), which collectively offer a comprehensive framework for analysing hybrid work and the acceptance of digital transformation from the employee perspective. The JD-R theory asserts that employee well-being, engagement, and sustainable performance are influenced by the balance between job demands including workload, cognitive demands, and role ambiguity and job resources such as autonomy, managerial support, and technology facilitation (Bakker & Demerouti, 2017). In hybrid work settings, digital technology can serve as essential job resources that improve flexibility, autonomy, and efficiency, or alternatively, as added job demands that exacerbate technostress, work intensification, and social isolation (Tarafdar et al., 2019). In conjunction with the JD-R model, the Technology Acceptance Model elucidates employees' adoption and continued utilisation of digital technologies, predicated on their perceived utility and perceived user-friendliness (Venkatesh & Davis, 2000). In hybrid work environments, employees' perceptions of digital platforms affect the quality of collaboration, performance management, and work-life boundaries. The integration of JD-R and TAM facilitates a comprehensive knowledge of how hybrid work and digital transformation collaboratively impact human capital sustainability through their effects on job design and technology-related perceptions.

Conceptual literature review

The *hybrid working* mode has evolved from earlier forms of remote working and flexible arrangements enabled by advances in information and communication technologies. The literature distinguishes between flexible hybrid models, fixed hybrid models, and remote-first hybrid models, reflecting varying degrees of employee autonomy and managerial control (Komna & Mpungose, 2024; Mergel et.al., 2019). Hybrid working is thus conceptualised not as a single model, but as a spectrum of arrangements shaped by organisational culture, leadership practices, and technological infrastructure.



Digital transformation refers to the integration of digital technologies into organisational processes, structures, and strategies to enhance efficiency, value creation, and adaptability. Its evolution can be traced from early computerisation and digitisation of analogue data to advanced digitalisation and strategic transformation enabled by interconnected technologies such as cloud computing, data analytics, and artificial intelligence (Simbolon & Sihombing, 2025). Scholars conceptualise digital transformation as a multi-dimensional process encompassing technological, organisational, and social dimensions (Angreni & Mahyuni, 2024). Technologically, it involves the adoption of digital platforms and automation tools; organisationally, it requires changes to workflows, governance, and decision-making; socially, it necessitates shifts in employee mindsets, skills, and work practices. These dimensions are particularly salient in hybrid working environments, where digital technologies mediate everyday work interactions and performance outcomes (Sołtysik et.al., 2024).

An empirical literature review.

Empirical studies consistently demonstrate that employees' perceptions of hybrid working are mixed and context dependent. Qualitative research indicates that while hybrid working enhances flexibility, autonomy, and efficiency, it also introduces communication challenges, reduced informal interaction, and trust-related concerns (Bredberg, 2023). Similarly, studies in public administration contexts reveal that limited managerial endorsement and inconsistent procedures undermine employees' adaptation to hybrid work, intensifying perceived job demands (Jab et al., 2024).

Hybrid Working and Wellbeing

The relationship between hybrid working, performance, and wellbeing has received growing empirical attention. Systematic reviews suggest that hybrid working can positively influence employee performance and wellbeing by enhancing flexibility and reducing commuting stress, provided that performance expectations and boundaries are clearly defined (Kusumawati, 2024). However, challenges related to performance monitoring, discipline, and extended working hours persist. Qualitative evidence further indicates that organisational support and work-life balance play critical mediating roles in determining hybrid work outcomes (Candra & Sabtohadhi, 2025). While flexibility enhances motivation and productivity, insufficient social interaction and reduced team cohesion may undermine psychological wellbeing. These findings underscore the relevance of JD-R assumptions regarding the balance between demands and resources in hybrid work settings.

Digital Transformation Adoption in Organisations

Empirical research on digital transformation highlights both its transformative potential and persistent implementation challenges. Studies identify inadequate skills development, weak change management, and limited investment in training as primary contributors to digital transformation failure (Van Dyk et.al., 2019). In public sector contexts, digital transformation has been shown to improve efficiency, service delivery, and citizen engagement, provided that it is supported by effective governance and employee capability development (Ohlert et.al., 2022). South African public sector studies reveal uneven progress in digital transformation, with challenges linked to outdated technologies, procurement delays, and limited inter-agency coordination (Komna & Mpungose, 2024). While certain digital initiatives enhance transparency and user engagement, their effectiveness is often undermined by structural and human capital constraints.

Digital Transformation and Hybrid Working



Emerging empirical evidence positions hybrid working as both an outcome and enabler of digital transformation. Digital tools that are perceived as user-friendly and useful facilitate collaboration, communication, and productivity in hybrid environments (Cho et.al., 2022). Conversely, poorly designed digital systems intensify job demands and resistance to change, reinforcing the importance of TAM in understanding hybrid work effectiveness. Han et.al. (2025) found that employees embrace the hybrid working mode because of its flexibility and the user-friendly digital tools that support the hybrid working mode. User-friendly digital transformation tools enable successful change management in the organisation and allow for indispensable communication and collaboration, as employees will be keen to explore the new technologies.

Research Design and Methodology

This section outlines the research design and methodological approach adopted to address the study's objectives. It details the research paradigm, design, research context, sampling strategy, data collection methods, data analysis procedures, trustworthiness, and ethical considerations.

Research Paradigm and Design

The study is positioned within an interpretivist research paradigm, which assumes that reality is socially constructed and best understood through individuals' subjective meanings and lived experiences. The interpretative paradigm allows a researcher to consider factors like behaviour from a participant's experiences, enabling the researcher to describe the reality of the content using assumptions and beliefs (Alharasheh & Pius, 2020). This paradigm assumes that reality is socially constructed and continuously evolves over time, rendering knowledge and facts relative and subjective (Melnikovas, 2018). This study employed an exploratory research design to understand the selected participants' perceptions of the hybrid working mode and digital transformation in their workplaces. This exploratory design included an open-ended interview process to gather data to answer the research questions.

Research Approach

A qualitative research design was adopted to explore the effectiveness of hybrid working and digital transformation adoption from the perspective of employees. Qualitative designs are particularly suitable for examining complex organizational phenomena, such as work redesign and technological change, where contextual factors, social interactions, and individual sense-making processes are central. This design allows the study to capture nuanced employee experiences related to job demands, job resources, technology acceptance, and human capital sustainability dimensions that are not easily quantified.

Population and Sample

A population of employees working for a selected public sector department was used to draw a sample for data collection. The department has 137 employees including, senior managers, unit managers, junior employees and employees from the corporate unit (information technology, human resources, finance and supply chain). A purposive sampling method was adopted in this study. This is defined as a population sampling process where a researcher selects participants based on their presence in a population of interest, characteristics, and experiences, amongst other things (Stratton, 2024). The sampling for this study focused on participants from each core unit (senior management, management, and senior investigators) and the corporate support unit, totalling at least nine participants. The study reached data saturation at a point where there were no new information, themes, or patterns that emerged from the data collection process. A point of



data saturation in a study indicates that the researcher has sufficiently investigated the topic and can stop collecting the data, without the risk of missing critical insights (Ahmed, 2025).

Research Instrument

An interview guide was developed by the researcher. It contained a set of six standard open-ended questions that were developed from the research questions. The interview guide included questions in numerical order and was sent to the participants three days before the interview to afford them a reasonable time to prepare. An interview protocol was annexed to the interview invite. During the interview session, follow-up questions were posed to the participants where there was a need for clarity or an in-depth understanding of the response.

Data Collection

Primary data were collected through semi-structured interviews, which provided a flexible yet systematic approach to exploring participants' experiences and perceptions. Semi-structured interviews are well-suited to qualitative HRM research, as they allow participants to articulate their views in their own words while enabling the researcher to probe issues related to job demands, job resources, technology use, and organisational support. The interview guide included questions in numerical order and was sent to the participants three days before the interview to afford them a reasonable time to prepare. An interview protocol was annexed to the interview invite. During the interview session, follow-up questions were posed to the participants where there was a need for clarity or an in-depth understanding of the response. The data obtained from the interviews were captured through recordings and notes; these were later transcribed. Each candidate had his/her transcribed script that was validated by listening to the recording; a pseudonym was assigned to each transcript to ensure anonymity and confidentiality.

This study followed a reflexive thematic analysis to analyse the data. A reflexive thematic analysis is referred to as the researcher's interpretative analysis of the data at the intersection of the dataset. It includes a theoretical assumption of the analysis and the researcher's analytical skills (Bryne, 2022). A thematic analysis involves identifying patterns or themes in qualitative data (Maguire & Delahunt, 2017). Braun and Clarke (2008) state that a thematic analysis involves six phases.

Results and Findings

This study examined hybrid working and digital transformation adoption as pathways for human capital sustainability in a South African public sector department through semi-structured interviews. Nine participants (out of ten selected) were interviewed across key functional areas. The sample included four managers, three junior employees, one IT technician, and one HR practitioner, working between 1 - 4 days per week from home. This role diversity enabled a balanced view of how hybrid work and digital tools are experienced across operational and support functions.

Objective 1: Employees' perceptions of hybrid working effectiveness

Overall, participants expressed strong support for hybrid working and perceived it as effective, primarily because it enabled greater productivity, flexibility, well-being, and reduced commuting strain, all of which align with the study's title emphasis on sustaining human capital through reimagined work arrangements.

Theme 1: Hybrid work enhances productivity through fewer disruptions and higher autonomy



Participants consistently reported being more productive at home due to reduced office interruptions and stronger control over schedules. This supports the view that hybrid work can increase performance by improving focus and enabling employees to manage work demands more efficiently, echoing broader hybrid work evidence that reduced distractions and greater autonomy can strengthen performance outcomes (Kusumawati, 2024).

Theme 2: Flexibility reduces commuting costs and stress, improving wellbeing—but can blur boundaries

Participants emphasised that hybrid work reduced commuting fatigue and expenses and enabled better scheduling around personal responsibilities, contributing to improved well-being. However, a minority highlighted boundary erosion (extended hours, skipped breaks), indicating that hybrid work can simultaneously function as a resource (flexibility) and a demand (constant availability). This directly connects to the sustainability dimension of the title: hybrid work supports human capital sustainability only when boundaries and recovery time are protected.

Theme 3: Reduced face-to-face conflict improves working relationships and psychological safety

A noteworthy finding was that hybrid work was perceived to reduce office conflict, as fewer in-person interactions lowered opportunities for friction. Participants described conflict as easier to manage through formalised digital channels. This suggests an indirect pathway through which hybrid work contributes to human capital sustainability: reduced workplace conflict can lower stress and protect well-being, supporting sustained engagement and performance.

Therefore, it can be concluded that hybrid working was experienced as effective when it enhanced job control, reduced commuting stress, and supported productivity, but its sustainability depended on managing work intensification and boundary blurring.

Objective 2: Employees' perceptions of digital transformation adoption

Participants viewed digital transformation adoption as central to the functionality of hybrid work, with a strong perception that digital tools improved efficiency, enabled remote work continuity, and modernised work processes, supporting the title's positioning of digital transformation as a pathway to sustainable human capital.

Theme 1: Digital tools enable efficiency and continuity of hybrid work

Participants identified key technologies adopted at their public sector department: Fortinet VPN, Microsoft 365, Teams, SharePoint, OneDrive/cloud systems, and shared drives. These tools enabled secure access to documents, real-time collaboration, and virtual meetings, allowing work-from-home to "feel like being at the office." This reflects that technology adoption is not peripheral but foundational to hybrid work effectiveness and employee capability.

Theme 2: Modernisation and cost saving through reduced paper-based processes

Participants reported major efficiency gains from reduced printing, fewer paper files, and less travel. A particularly compelling example was the replacement of travel-based verification work with virtual engagements, indicating that digital transformation can yield cost savings and faster turnaround while sustaining service delivery. This aligns with the title's "reimagining" framing: digital adoption changes not only *where* work happens, but *how* public sector work is executed and delivered.



In summary, digital transformation adoption was experienced as effective when it supported seamless access, collaboration, and process modernisation, reinforcing the argument that hybrid work effectiveness is inseparable from meaningful digital enablement.

Objective 3: Challenges and opportunities of implementing hybrid work and digital transformation

While participants strongly supported hybrid work and digital adoption, they highlighted critical barriers that constrain effectiveness and threaten human capital sustainability if left unresolved.

Key Challenge 1: Uneven digital maturity across units creates equity gaps

Participants reported that some units remained paper-based due to specialised systems not yet procured. As a result, certain employees were more office-bound than others, limiting equal access to hybrid work benefits. This is a major sustainability issue: inequitable access to hybrid arrangements can weaken fairness perceptions, morale, and long-term engagement.

Key Challenge 2: Connectivity and personal cost burdens

Participants raised concerns about the cost of data/internet and the expectation to route office calls through personal phones. These issues suggest that hybrid work may shift operational costs to employees, potentially undermining wellbeing and perceptions of organisational support, both critical to sustaining human capital.

Key Challenge 3: Performance monitoring and managerial control in hybrid contexts

Managers described difficulty monitoring performance without micromanaging, while others reported delayed responses and missed timelines from some colleagues. This signals the need for redesigned performance systems focused on outputs, clarity, and trust rather than presence-based control.

Key Challenge 4: Lack of training limits effective utilisation of digital tools

A recurrent concern was insufficient training on Microsoft 365 capabilities and related tools, leading to underutilisation and confusion. Participants argued for organisation-wide, standardised training and clearer internal communication. This gap directly affects sustained digital adoption and hybrid work effectiveness.

This concludes that Participants highlighted improved customer service through virtual meetings, faster clarification, and reduced travel for stakeholders. Microsoft Teams enabled quick consultations and verifications. This opportunity links strongly to public sector outcomes: hybrid work and digital transformation can support public value by strengthening responsiveness and accessibility. The transition created a strong opportunity for improved stakeholder service and modernisation, but effectiveness is constrained by unequal digitisation across units, cost burdens, limited training, and incomplete performance monitoring systems.

Managerial Implications

The findings of this study have significant managerial implications for public sector leaders seeking to institutionalise hybrid working and digital transformation as sustainable human resource management practices. The results indicate that hybrid working should be reframed from an informal flexibility arrangement to a strategic work design intervention that directly shapes job demands, job resources, and long-term human capital sustainability. Consistent with the Job Demands-Resources (JD-R) model, hybrid working enhances employee productivity and well-



being when it increases autonomy, reduces commuting strain, and minimises unnecessary interpersonal conflict. However, without clear managerial structures, it may also intensify job demands through boundary blurring, extended working hours, and coordination challenges (Bakker & Demerouti, 2017; Wang et al., 2021). Managers are therefore encouraged to formalise hybrid working through clear policies that define expectations around availability, performance outputs, and recovery time, while shifting performance management from presence-based monitoring to outcome-oriented evaluation.

The study further highlights the need for managers to actively manage job demands associated with hybrid working to protect employee wellbeing and sustain performance. While flexibility was widely experienced as a resource, some employees reported work intensification and difficulty disconnecting from work, indicating risks of burnout if boundaries are not explicitly managed. This suggests that hybrid working sustainability depends not only on flexibility but also on managerial practices that regulate workload, meeting intensity, and digital availability norms (Kusumawati, 2024; Tarafdar et al., 2019). Managers should therefore establish boundary-management guidelines, such as agreed response times, protected non-working hours, and realistic workload planning, and model these behaviours themselves to reinforce a culture of sustainable performance.

Digital transformation adoption emerged as a critical enabler of hybrid working effectiveness, underscoring the importance of technology acceptance as explained by the Technology Acceptance Model (TAM). Employees perceived digital tools such as Microsoft 365, Teams, VPNs, and cloud-based systems as highly useful in enabling collaboration, access, and efficiency, which facilitated their acceptance and sustained use. However, the findings also reveal that insufficient training and inconsistent support reduce perceived ease of use, converting digital tools into sources of frustration and additional job demands (Venkatesh & Davis, 2000; Schilirò, 2024). Managers should therefore prioritise continuous digital capability development through structured training, on-demand support, and peer learning mechanisms to ensure that technology functions as a job resource rather than a stressor.

In sum, the findings suggest that hybrid working and digital transformation can function as sustainable pathways for human capital development in the public sector when managers deliberately balance job demands and resources, support technology acceptance, address structural inequities, and modernise performance and capability systems. Without such intentional managerial action, the sustainability potential of hybrid work and digital transformation remains fragile and uneven.

Conclusions and Future Research

This study set out to explore hybrid working and digital transformation adoption as pathways for human capital sustainability in the public sector, drawing on employees' lived experiences within a South African public sector organisation. Guided by the Job Demands–Resources (JD-R) model and the Technology Acceptance Model (TAM), the findings demonstrate that hybrid working and digital transformation are not independent initiatives but interdependent systems that jointly shape employee wellbeing, engagement, and sustainable performance.



The findings show that hybrid working is largely perceived as effective when it enhances autonomy, flexibility, productivity, and well-being, primarily through reduced commuting, fewer workplace disruptions, and improved control over work schedules. These outcomes reflect the role of hybrid work as a job resource within the JD-R framework, supporting motivation and sustained performance (Bakker & Demerouti, 2017; Wang et al., 2021). At the same time, the study highlights that hybrid working can also generate new job demands, particularly through blurred work–life boundaries, extended working hours, and coordination challenges. This duality underscores that hybrid working contributes to human capital sustainability only when job demands are actively managed and recovery opportunities are protected.

Digital transformation adoption emerged as a critical enabler of hybrid working effectiveness. Employees perceived digital tools such as Microsoft 365, Teams, VPNs, and cloud-based systems as highly useful in enabling collaboration, access, and efficiency, validating the central assumptions of TAM regarding perceived usefulness (Venkatesh & Davis, 2000). However, insufficient training and uneven system maturity constrained perceived ease of use, transforming digital tools into sources of frustration and techno-stress for some employees. These findings confirm that technology functions as a job resource only when it is accepted, usable, and supported, reinforcing the importance of integrating TAM into sustainable HRM analyses of hybrid work.

Future research could extend the proposed JD-R and TAM framework through quantitative or mixed-methods designs to test the relationships between hybrid working arrangements, technology acceptance, job demands, job resources, and human capital sustainability outcomes. Longitudinal designs would be particularly valuable in examining how employee experiences evolve over time as hybrid work becomes institutionalised and digital transformation matures.

In conclusion, this study contributes to international HRM scholarship by demonstrating that reimagining hybrid working and digital transformation as interconnected systems rather than isolated practices offers a more robust pathway to sustaining human capital in the public sector. By integrating JD-R and TAM, the study advances theory and practice on sustainable work design in digitally enabled public organisations and provides a foundation for future research that is context-sensitive, employee-centred, and policy-relevant.



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Work-in-Progress: Abstracts



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The potential of knowledge management as a service to enhance the productivity and sustainability of small-holder farmers in South Africa

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Abstract

This work in progress proposes a framework for adopting Knowledge Management as a Service (KMaaS) to enhance knowledge sharing in sustainable food systems for small-scale farmers. The aim is to address continual knowledge gaps that hinder agricultural productivity, sustainability, and resilience. By combining cloud-based digital tools with mechanisms for curating localized, context-specific know-how, the proposed framework seeks to democratize access to vital information on sustainable practices, market access, and climate adaptation.

Through the guidance of the research onion, and a pragmatic research paradigm, the study will employ a mixed-methods research design. This approach will collect and analyze both qualitative data (interviews) and quantitative data (surveys) to systematically explore the socio-technical dynamics of KMaaS adoption. The investigation is underpinned by an integration of three key theoretical models: Actor-Network Theory (ANT), mapping the human and non-human actors in the knowledge network; the Hierarchy-of-Effects (HOE) model, which tracks stages of behavioral change; and the Technology-Organization-Environment (TOE) framework, which assesses contextual drivers and barriers.

The anticipated findings will outline the critical success elements and strategies for successful KMaaS adoption in agricultural environments with limited resources. This will culminate in a tested, integrated framework that points out the interactions between technology, community actors, and localized content. The study's contribution is twofold. Theoretically, it advances knowledge management literature by synthesizing ANT, HOE, and TOE into a unique lens for analyzing adoption processes in agriculture. Practically, it provides actionable guidance for policymakers, NGOs, and technology developers to design KM services that are both technically robust and culturally resonant, directly contributing to Sustainable Development Goals (SDGs) 1 (No Poverty), 2 (Zero Hunger), and 8 (Decent Work and Economic Growth) by aiming to improve food security, economic outcomes, and collaborative innovation for smallholder communities. This framework is expected to enhance the adoption of KMaaS solutions and positively impact small-scale farming sustainability. Recent evidence from SMEs and manufacturing sectors demonstrates that digital knowledge platforms significantly improve green innovation performance (Jalil et al., 2025), environmental outcomes (Sahoo et al., 2022), and multi-dimensional sustainable development (Zhuge et al., 2023)

Keywords: Knowledge Management, Knowledge Sharing, Sustainability, Small-scale Farmers, KMaaS, Actor-Network Theory, Hierarchy of Effects, TOE Framework, SDGs, Mixed-Methods Research.



Determinants of Multidimensional Drought Vulnerability in Somalia: Exposure, Sensitivity, and Adaptive Capacity

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Abstract

Drought remains one of the most critical environmental challenges contributing to economic fragility in Somalia. This study adopts a multidimensional approach to analyse the determinants of households' drought vulnerability index (DVI), based on exposure, sensitivity, and adaptive capacity. Data were from 2,540 households surveyed in 2022 during the second round of Somalia's High-Frequency Phone Survey of displaced people. Principal Component Analysis (PCA) was applied to aggregate variables, and normalised values were used to construct the vulnerability indices. Tobit regression models were estimated for each vulnerability dimension and the composite DVI. The results reveal that the average drought vulnerability was 48.32%, with corresponding exposure (45.90%), sensitivity (42.52%), and adaptive capacity (11.44%). Tobit regression showed that indicators of drought exposure, sensitivity and adaptive capacity significantly increased with some income sources. However, households with increased income had higher exposure but lower sensitivity. Disability reduced exposure but increased sensitivity and adaptive capacity. Engagement in economic activities and looking for new jobs increased the three indicators, refugees and returnees had lower values. Rural residents had higher exposure, but urban and rural dwellers had lower sensitivity compared to those in camps. Residents in Jubaland and the South West States had higher exposure and sensitivity. Also, DVI increased significantly with disability, looking for new job, economic activities, the number of 6-17 years old children, residence in Jubaland, South West State, and some income sources, but reduced with UNHCR assistance, the number of 0-5 children, being a refugee, being a returnee, and urban residence. These findings underscore the complexity of household vulnerability in fragile settings with the dual role of some livelihood and demographic variables on different vulnerability indicators. The findings beckon policymakers and humanitarian agencies to promote targeted interventions to increase adaptive capacity, reduce sensitivity, and improve resilience against recurrent droughts in Somalia.

Keywords: Drought, Vulnerability, Indicator, Exposure, Sensitivity, Adaptive Capacity



Leveraging IoT-Enabled Precision Beekeeping For Sustainable Agriculture and Pollinator Conservation

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Abstract

A large proportion of agricultural crop yield is dependent on pollination. Data from the Food and Agriculture Organization of the United Nations indicated that 35 percent of global land is affected by pollinators. In monetary terms, this translates to \$235 to \$577 billion United States Dollars a year for global crops that directly rely on pollinators. This project aims to empower smallholder farmers who currently contribute to over 75 percent of Zimbabwe's bee production through the adoption of Artificial Intelligence in beekeeping and integration with cereal and oilseed production. This addresses the need for sustainable agricultural practices, improving crop yield and quality, and increasing income for rural smallholder farmers. The primary objective of this project is to enhance the capacity of smallholder farmers to adopt new improved technologies in beekeeping through developing and deploying precision Agriculture technologies suitable to Zimbabwe to monitor bee health, hive activity and pollination efficiency, to measure and quantify the impact of precision beekeeping on crop yields, bee population growth and ecosystem health, to co-design and test IoT-enabled precision agriculture solutions with farmers and beekeepers, ensuring inclusiveness, local relevance, and long-term adoption of the technologies and to train farmers and beekeepers in precision agriculture and sustainable practices to enhance collaboration and knowledge –sharing. To achieve our objectives, we will employ a multi-faceted approach that combines training, demonstration, community engagement, and on-farm trials. This will include a needs assessment and baseline study to identify specific needs and opportunities for precision beekeeping in the Mashonaland East province in Zimbabwe. Using the pre-existing database provided by the Department of Agricultural and Rural Development Advisory Services under the Ministry of Lands, Agriculture, Fisheries, Water, and Rural Development, one beekeeper will be selected using purposive sampling from each of the nine districts. The research follows a Quasi-Experimental research design with a multi-site study approach. The selected nine farmers will be furnished with a complete set comprising ten Langstroth beehives, a solar-powered AI monitoring system paired with a wireless network for real-time monitoring by both the farmers and the project command center. Adoption of precision beekeeping has the potential of addressing sustainable development goals 1, 7, 11, and 12. The project will be implemented over a period of 18 months with specific milestones including needs assessment, training and capacity building programs, establishment of on-farm trials for 3 consecutive crop rotations and growing bee forage, and implementation of the AI monitoring system.

Keywords: beekeeping, conservation, precision, rural, solar, sustainable



Development of an automated single axis solar-tracking system powered Internet of Things (IoT) Framework for monitoring water quality in the fish-farming sector in Zimbabwe; Case study of Women's University in Africa farm, Marondera, Zimbabwe

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Abstract

The Ministry of Lands, Agriculture, Fisheries, Water, and Rural Development reports fish production rose from 20,000 to 33,000 tonnes between 2022 and 2024, attributed to the Agriculture, Food Systems, and Rural Transformation Strategy and the Presidential Community Fisheries Scheme. Despite expanded pond construction and technical support, smallholder aquaculture still lacks reliable, real-time water-quality monitoring and backup power, limiting timely interventions and risking fish health.

This study aims to develop an automated water-environment sensor paired with a single-axis solar-tracking pumping system to maximize solar energy capture and provide reliable power for water exchange, irrigation, and on-farm electricity. The trial will be conducted at the Women's University in Africa farm, Marondera, Mashonaland East, Zimbabwe, using a quasi-experimental, multi-site approach with a completely randomized design and three replicates per treatment.

Nine fish ponds (10 m × 5 m) will be constructed and stocked with 1,000 *Oreochromis niloticus* per fish pond. Treatments include: Control (traditional practices); Treatment 1 (wireless monitoring or drainage powered by a fixed solar array); and Treatment 2 (monitoring with a single-axis solar-tracking system). Outcomes to be measured include water-quality parameters (pH, dissolved oxygen, temperature), fish performance metrics (growth rates, feed conversion), and system performance indicators (energy output, sensor reliability). Expected outcomes include reduced labour, enhanced energy efficiency, and improved environmental sustainability through nutrient-rich fertigation. Furthermore, the adoption of Artificial Intelligence (AI) monitored aquaculture will be integrated through automated data analysis for predictive water-quality trends and autonomous interventions, such as triggering solar-powered pumping cycles when oxygen levels drop below critical thresholds. This framework has the potential to address Sustainable development goals 1, 7, 11, and 12. The project will be implemented over 12 months.

Keywords: Artificial Intelligence, Automated, fertigation, single-axis, solar, water-quality



Do sustainability orientations translate into innovation? Global student entrepreneurship pathways, 2021–2023

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Abstract

Sustainability has become a central theme in student entrepreneurship research, with a growing body of empirical studies suggesting that sustainability-oriented values and attitudes are associated with stronger green entrepreneurial intentions and certain forms of innovative behaviour. This relationship appears particularly pronounced in university ecosystems that explicitly support sustainable and green entrepreneurship. However, the extent to which these orientations translate into more substantive and potentially scalable innovation outcomes remains empirically underexplored. Drawing on global data from the Global University Entrepreneurial Spirit Students' Survey (GUESSS) 2021 and 2023, this paper examines how sustainability orientations, innovation-related behaviours, and entrepreneurial engagement combine into distinct pathways among student entrepreneurs worldwide. The analysis integrates measures of sustainability-driven motivations, innovation orientation and behaviour, perceived social and environmental performance, sectoral preferences, and university support for sustainable development. Rather than assuming a linear progression from sustainability values to innovation outcomes, the paper adopts a configurational perspective to identify heterogeneous sustainability–innovation pathways. Comparative analysis across the two survey waves reveals that stronger sustainability orientations do not uniformly translate into higher levels of innovativeness or entrepreneurial activity. Instead, multiple pathways emerge, including profiles characterised by strong normative sustainability orientations with limited innovation, alongside innovation-driven entrepreneurial pathways with explicit sustainability goals. By providing global, data-driven evidence on the uneven translation of sustainability orientations into innovation, the paper contributes to rethinking innovation pathways for sustainability and highlights the need for more differentiated, context-sensitive approaches in entrepreneurship education and policy.

Keywords: Innovation pathways, Student entrepreneurship, Sustainability-oriented entrepreneurship, University ecosystems



Stakeholder Perceptions Of The Impact Of Mine Closures on Rehabilitation in the KOSH-Areaitle of the WIP Paper

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Abstract

The closure of mines and the prevalence of unrehabilitated mining sites have significant environmental, economic, and social repercussions for host communities. This study investigates the impacts of mine closures and unrehabilitated mines in the KOSH-area, focusing on environmental hazards, socioeconomic challenges, policy shortcomings, and sustainable development. The research approach was qualitative, with semi-structured interviews conducted with diverse stakeholders, including residents and community leaders, to explore the lived experiences and perceptions of affected populations. The findings highlight environmental degradation, characterised by water pollution, deteriorating air quality, and the loss of arable land. Economically, mine closures have exacerbated unemployment, reduced household incomes, and destabilised local businesses, intensifying poverty in already vulnerable areas. Despite South Africa's comprehensive policy framework, enforcement and accountability remain inadequate, with rehabilitation measures often limited to superficial interventions. To address these challenges, the study recommends strengthening policy enforcement through an independent regulatory body, establishing mandatory rehabilitation funds, and aligning mining practices with the United Nations Sustainable Development Goals (SDGs). Community engagement emerged as a critical component, advocating for inclusive decision-making and leveraging local labour in rehabilitation projects.

Keywords: environment, KOSH-area, SDGs, rehabilitation, sustainability, mining.



Farming Systems Towards Sustainable Livelihoods: Literature Review Analysis Using Atlas.ti

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Abstract

The world population requires access to sustainable food supply across nations which has been challenges in many nations, especially the Global South. This qualitative study is anchored on the UN's Global Strategic Framework (GSF) in the northern KwaZulu-Natal to address lack of food security. The access to consistent food is enshrined in the South African Constitution (Chapter 2 - Bill of Rights). The paper seeks to uncover key thematic ideas in the peer-reviewed academic journals to inform the current study. The study seeks to understand in-depth the scholars key findings and recommendations to address the lack of food security in households. The study aims to analyse literature on food systems using Atlas.ti to inform sustainable livelihoods. The academic papers were sourced from database, for example, Sabinet, EbscoHost, Web of Science, and Google Scholar covering 2021-2025. The key thematic findings inform the current study on small scale farmers contribution towards community sustainable livelihoods. Findings revealed dominant themes such as agroecological systems, efficient farming systems, precision farming and changing climatic conditions. The findings provides key learnings that will assist farmers to improve farming systems to address poverty alleviation and inequality reduction. Additionally, further research could test these thematic ideas in rural KZN field settings. Furthermore, securing food security at the village level will broadly contribute towards a country's ability to meet the United Nations' Sustainable Development Goals (SDG) 1 and 2 which refer to the eradication of poverty and hunger respectively.

Keywords: Atlas.ti, farming, food security, livelihood, small-scale, sustainability

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Optimizing Industrial Baseload Resilience: The Thermoka Hybrid Energy System Architecture for Energy-Intensive Sectors

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Abstract

The South African industrial sector faces a structural crisis defined by severe energy cost volatility and escalating carbon tax liabilities that threaten operational safety and business continuity. This research presents the Thermoka Hybrid Energy System, an innovative, decentralized baseload architecture designed to decouple large-scale operations from grid instability through a hierarchical "Cascaded Thermal Bus" strategy. By matching Medium-Temperature Concentrated Solar Power (CSP) and high-grade industrial waste heat to a modular Organic Rankine Cycle (ORC) power block, the system achieves a total thermal utilization efficiency exceeding 70%. Thermodynamic modelling, calculated conservatively for extreme ambient temperatures, confirms a real-world thermal efficiency of 18.6% utilizing R245fa as a working fluid, with a 3.5% absolute efficiency gain recovered through an innovative "Hybrid Switching" dual-mode cooling architecture. Furthermore, the system integrates a packed-bed molten salt thermocline for long-duration thermal storage and Vanadium Redox Flow Batteries (VRFB) for grid stability. Technical validation indicates a 97.7% reduction in electrical boiler loads and a conservative payback period of less than four years when factoring in South Africa's Section 12L Energy Efficiency Tax Incentives and the significant mitigation of Carbon Tax liabilities. These findings demonstrate that a transition to multi-modal thermal recovery provides a robust, bankable solution for diverse industrial environments, aligning with global decarbonization mandates while ensuring continuous power for the African commercial sector.

Keywords: baseload resilience, cascaded thermal bus, hybrid energy, industrial decarbonization, organic rankine cycle, thermal storage



Autonomous Resilience in Off-Grid Vaccine Cold Chains: The Thermoka Solar-Thermal Absorption Clinic Cooler

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Abstract

Medical cold-chain infrastructure in the Global South faces a persistent structural failure driven by the limited lifespan of electrochemical batteries and the mechanical degradation of vapor-compression refrigeration systems operating in harsh, off-grid environments. This research, originating from South Africa, presents the Thermoka Solar-Thermal Absorption Clinic Cooler, an alternative engineering paradigm that replaces electrochemical storage with a dual-phase thermal battery and mechanical compressors with a chemically driven lithium bromide–water (LiBr–H₂O) absorption cycle. Using a physics-based validation framework, system performance was assessed against WHO PQS E003 standards, incorporating Generator–Absorber Heat Exchange (GAX) cycles and Model Predictive Control (MPC) to enhance thermodynamic efficiency. Results demonstrate stable vaccine storage temperatures between +2 °C and +8 °C under ambient conditions exceeding 40 °C, enabled by 19.1 kg of cold phase-change material (PCM) delivering more than 72 hours of autonomous operation without solar input. The integration of vacuum insulation panels (VIPs) reduces thermal ingress by a factor of six, allowing the system to operate with a compact 1.5 m² solar collector array. Beyond technical robustness, the system achieves a projected maintenance-free lifespan of 8–12 years with zero global-warming potential, directly supporting UN Sustainable Development Goals through improved vaccine access in high-need regions. These findings demonstrate that a transition from power-electronics-dependent architectures to thermodynamically robust systems can significantly reduce total cost of ownership for critical global health infrastructure.

Keywords: absorption refrigeration, cold-chain resilience, phase-change material, solar-thermal, vaccine storage, water-libr cycle



The Mediating Role of Attitude on Young Consumers' Plant-based Product Purchase Intentions Amid the Climate Crisis

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Abstract

A shift towards a predominantly plant-based (PB) diet to reduce, and possibly reverse, the negative environmental, animal, and human health impact of industrial animal agriculture, is imperative (Agudelo Higueta, LaRocque, & McGushin, 2023), to address particularly sustainable development goal (SDG) 12, sustainable consumption as well as food security and sustainable nutrition. South Africa (SA) is vulnerable to natural disasters caused by anthropogenic climate change. In addition, the COVID-19 (C19) pandemic sparked a wave of PB food consumption among consumers due to the health and nutrition benefits. Young consumers are dubbed the 'green generation' (Bonera, Codini, & Miniero, 2020), due to their environmental concern and behaviours. Borges-Tiago, Almeida, Tiago, and Avelar (2024) indicated that attitudes (ATT) serve as a bridge between values and actual purchase intentions, thus indicating a possible mediation role. This study therefore sought to determine the mediating role of attitudes towards PB products between known green behaviour antecedents such as Environmental Concern (EC), Environmental Knowledge (EK), and Health Consciousness (HC), including the Concern about the C19 Pandemic (CC19P), as independent variables and PB Product Purchase Intentions (PBPPI) (dependant variable), among young consumers. This study is necessary at this critical juncture of climate crisis escalation, as understanding the determinants of PB product adoption in an emerging economy, most vulnerable to climate change, is vital for promoting dietary habits that help mitigate climate change impacts. A cross-sectional descriptive correlational research design was employed. A questionnaire, with established multi-item scales from extant literature was developed for the constructs using continuous five-point Likert scales, which were administered to a quota sample of 381 students within a tertiary institution, as an accessible sample of young consumers in SA. The questionnaire was pre-tested and self-administered. After data screening, skewness, kurtosis and multicollinearity were checked.

Exploratory factor analysis was applied to explore the structure of the items in each construct and confirm the factorability of the data. Structural equation modelling (SEM) was performed for testing the proposed hypotheses and model fit. Mediation analysis was conducted. The sample revealed a skewed gender mix of 62% females to 38% males, which was reflective of the university student mix. Most of the respondents (93%) were in the 18–25-year group, Black Africans (78%), which supports the study objectives and South African population. ATT was by far the greatest predictor of PBPPI with a regression coefficient of 0.584 ($p = < .001^*$). Although EK, EC and CC19P did not directly impact PBPPI, they indirectly significantly affected PBPPI through ATT as a full mediator. No significant mediating effect was observed for the relationship between HC and PBPPI possibly because basic needs and cost considerations are the primary drivers of consumer food choices in SA (Ronquest-Ross & Sigge, 2024), thus overriding the more nuanced relationship between HC, ATT, and purchase intention.

This study extended the TPB model to incorporate variables valid in the new era of climate crisis and pandemic scares in SA, also introduced a new variable – CC19P, and developed a new scale, found to be reliable and valid, to capture the attitudes of young consumers' concerns surrounding



the pandemic, which could be useful for measuring attitudes towards other zoonotic diseases. To promote more sustainable consumption (SDG12) and particularly sustainable nutrition and food security, policymakers and organisations need to increase the awareness and knowledge of the positive effects of PB products on the health of humans and the environment to increase young consumers' environmental knowledge as this impacts attitudes towards these products which in turn significantly increases intentions to purchase these products. Documenting the negative effects of meat-based relative to PB products can also contribute to the existing climate crises communication as increased concern for the environment also increases positive attitudes towards PB products. Another avenue for increasing PB product intentions is through communication of the evidence linking of COVID-19-type zoonotic diseases to animal consumption (Haider et al., 2020; WorldHealthOrganization, 2020) because this study found that increased concern about such pandemics improves attitudes towards PB products, which in turn increase intentions to purchase.

Keywords: attitude, climate crisis, COVID-19 pandemic, plant-based, sustainable, young consumers



Enhancing Accessibility in Distance Learning for Students with Special Needs: Challenges and Innovations in Higher Education

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Abstract

As distance learning becomes a cornerstone of modern education, ensuring equitable access for students with special needs remains a critical concern, particularly in developing countries like Rwanda. The rapid shift to online education, accelerated by the COVID-19 pandemic, exposed and, in some cases, widened pre-existing disparities in access to educational resources. While global studies have examined digital inclusion, few empirical analyses have focused on post-pandemic accessibility practices in African higher education institutions (HEIs) a gap this study seeks to address. This research explores the challenges and emerging innovations related to accessibility for learners with disabilities within Rwandan higher education institutions, with a specific focus on the transition to digital learning environments. Using a qualitative case study approach, the study examined three Rwandan universities, including the University of Kigali, to assess institutional readiness, technological infrastructure, pedagogical adaptations, and student support systems in delivering inclusive distance education. Data were collected through semi-structured interviews with 15 participants, comprising university administrators, faculty members, and students with special needs. In addition, institutional policy documents and digital learning platforms were analyzed to evaluate alignment with inclusive education standards. Findings reveal multiple barriers that hinder the full participation of students with disabilities. These include limited availability and affordability of assistive technologies such as screen readers and captioning tools, a lack of specialized training among faculty in inclusive teaching methods, and the absence of digital content designed for diverse learning needs. Moreover, infrastructural challenges such as unreliable internet access and inadequate personal devices further constrain engagement in online learning. Despite these challenges, the study identifies several promising innovations. Notable among them are the gradual integration of screen reader-compatible platforms, the development of customized learning management systems (LMS) that accommodate a range of accessibility needs, and strategic partnerships with disability advocacy organizations to co-create inclusive digital content. These initiatives reflect a growing commitment to inclusive and sustainable education in Rwanda. Key recommendations include policy reforms to mandate inclusive practices, targeted funding to procure assistive technologies, inclusive curriculum design grounded in Universal Design for Learning (UDL) principles, and comprehensive capacity-building programs for educators. By addressing these areas, Rwandan institutions can contribute directly to Sustainable Development Goal (SDG) 4—Quality Education, SDG 9—Industry, Innovation, and Infrastructure, and SDG 10—Reduced Inequalities, thereby advancing equitable and inclusive distance education in the digital era.

Keywords: distance learning, special needs education, accessibility



Amid Climate Change Disasters: An Ubuntu-Centred Climate Disaster Response Framework for Social Work Education and Practice

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Abstract

Climate-related disasters have increasingly affected communities across South Africa, exposing the limitations of reactive, individualised and Western-centric response and intervention frameworks. Despite the frequency and severity of flood disasters, psychosocial interventions remain fragmented, culturally misaligned, and insufficiently trauma informed. Guided by decolonial philosophy and the Afrocentric worldview of Ubuntu, this article addressed a critical gap in existing disaster response frameworks by proposing an empirically grounded, Ubuntu-Centred Climate Disasters Response Framework (UCDF). Drawing on findings from four qualitative studies conducted between 2022 and 2025 with flood-affected communities and frontline social workers in KwaZulu-Natal and the Eastern Cape, the article reconceptualises disaster-related trauma as a collective, historically embedded, and structurally produced experience rather than an individual pathology. The framework is organised into three interconnected phases, namely, *Aluminise* (Stabilisation), *Ukuhamba* (Navigation), and *Ukwakha* (Building), which operationalise trauma-informed principles through indigenous resilience practices, collective sense-making, and eco-social justice advocacy.

Findings demonstrate that integrating Ubuntu-based solidarity, indigenous practices, and community-led advocacy enhances psychosocial recovery, strengthens social cohesion, and repositions social work beyond crisis intervention. The article concludes with recommendations for social work education and curriculum development, practitioner training, supervision, and policy reform to align with this framework and embed it into social work professional practice and education.

Keywords: climate disaster, community resilience, cultural sensitivity, decolonial social work, trauma-informed practice, Ubuntu-Centred Climate Disaster Response Framework (UCDF)



Ukuphilisa Abantu: A Decolonial, Ubuntu-Centred Framework for Social Work in South African Climate Disasters

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Abstract

The escalating frequency of climate disasters necessitates a shift in social work from reactive crisis intervention to a proactive, trauma-informed framework. While the core principles of Trauma-Informed Care provide a valuable global standard, their conventional application through Western models proves insufficient in the South African context where trauma is collective, historical, and systemic. Methodologically, this paper provides a conceptual framework designed to build a new, practice-oriented model from existing knowledge on climate disasters. It constructs the Ukuphilisa Abantu framework, a detailed three-phase practical guide that moves social work practitioners from immediate stabilization and Ubuntu-centred support to long-term community self-determination. Using the context of recent South African disasters as a backdrop, this paper serves as a vital resource for social work training, practice, and policy, designed to foster genuine recovery and community resilience.

Keywords: disaster social work, decolonial social work, Trauma-Informed Care (TIC), Ubuntu, community resilience, cultural sensitivity, disaster recovery, South Africa.



Exploring the Preparedness and Systemic Challenges of Social Workers in Climate Disasters: A Case Study of the Eastern Cape Province

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Abstract

Globally climate disasters have intensified. In South Africa, several provinces are repeatedly affected by floods, suggesting a need for prepared and trauma-informed professionals. In the Eastern Cape province (EC), South Africa recent floods have increased and revealed a need for trauma-informed social work while exposing the profound frailties of the social service system. Based on the lived experiences of frontline social work practitioners in the Eastern Cape province, this article explores the preparedness and trauma informed capabilities of social workers during climate change disasters. This study adopted a qualitative research approach with data collected through a focus group discussion conducted with thirteen registered (13) social workers. Guided by a Green Social Work framework and thematic analysis, the findings revealed deep psychological trauma, precarity defined by unclear roles, a lack of capacity and training in trauma-informed approaches, crippling resource shortages, and severe secondary trauma. The article argues that these challenges are symptoms of a structural failure to integrate environmental justice into policy, and highlights the urgent need for contextually grounded, practitioner-focused green social work approach that is responsive to both global professional struggles and local, Afrocentric knowledge systems.

Keywords: afrocentric social work, climate disasters, green social work, practitioner support, South Africa



Renewable electrical energy system for Vaal River Coastal Inhabitants based on water lettuce and water hyacinth

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Abstract

This innovation project addresses the dual challenges of invasive aquatic weed pollution in the Vaal River and high electrical tariffs during peak demand periods for local Gauteng estate. I propose an intelligent power management system that converts harvested Water Lettuce (*Pistia stratiotes*) and Water Hyacinth (*Eichhornia crassipes*) into biogas for on-site electricity generation. The core innovation is a machine learning (ML)-based predictive model that forecasts biogas yield from harvested biomass and the corresponding electrical energy output. This system is designed to support a riverside estate business during its peak customer days (Friday to Sunday), actively reducing grid consumption during high-tariff periods. The project directly contributes to sustainable development by cleaning a critical water resource, generating renewable energy, lowering operational costs for local enterprise, and providing a replicable model for circular economy practices. Expected outcomes include a functional prototype ML model, a validated techno-economic analysis showing tariff reduction, and a scalable blueprint for community level application.



Environmental Challenges and Sustainable Development Pathways in Africa

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Abstract

Africa's quest for sustainable development continues to face mounting environmental challenges such as burdened deforestation, land degradation, and carbon emissions that deter the achievement of Sustainable Development Goals (SDGs). Undermining renewable energy adoption and regional economic reforms, hence, this study empirically examine the relationship between environmental degradation and sustainable development performance across Africa, by identifying the key drivers that either promote or constrain sustainability. Precisely, the study investigates how deforestation, CO₂ emissions, land degradation, renewable energy consumption, and governance quality affect Sustainable Development in Africa with an underpinning theories of the John Elkington (1994, 1997), and the Environmental Kuznets Curve (EKC) which suggests that environmental degradation originally rises with development but ultimately declines as income and environmental awareness rises. Therefore, integrating this theoretical lens allows the study to determine if Africa is moving toward or away from the sustainable phase of the curve. The study covers 25 year period (2000–2024), and utilises secondary panel data for 45 African countries, sourced from the World Bank's Development Indicators (WDI), Food and Agriculture Organization (FAO), and United Nations Environment Programme (UNEP) databases.

Based on the inevitable endogeneity, unobserved heterogeneity, and serial correlation associated with macro-panel data, the research employs the System Generalized Method of Moments (SGMM) estimator proposed by Arellano-Bover and Blundell-Bond. The dependent variable is the Sustainable Development (SD), while explanatory variables include deforestation rate, carbon emissions per capita, land degradation index, renewable energy use, and environmental governance index. Results shows that deforestation ($\beta = -0.218$, $p < 0.01$), CO₂ emissions ($\beta = -0.153$, $p < 0.01$), and land degradation ($\beta = -0.124$, $p < 0.01$) has negative and statistically significant effects on sustainable development, showing a crowd-out effect, which also confirmed that environmental degradation remains a critical obstacle to Africa's sustainable development. Furthermore, renewable energy consumption ($\beta = 0.192$, $p < 0.01$) and environmental governance ($\beta = 0.276$, $p < 0.01$) significantly improve sustainability outcomes, suggesting that investments in green technologies and strong institutional capacity are key pathways to sustainability. However, the lag sustainable development ($\beta = 0.431$, $p < 0.01$) indicates persistency in sustainable development performance across the study period, signifying that previous sustainability achievements positively influence current development. Diagnostic tests shows absence of second-order autocorrelation and validity of instruments (Hansen J-test $p = 0.214$), confirming the robustness of the model.



This study confirmed that Africa's sustainable development trajectory depends on integrating economic growth with environmental stewardship, which validates the John Elkington (1994, 1997) theory, but invalidate the Grossman & Krueger (1991) theory due to countries specific effects. Hence, concludes that sustainable development in Africa is attainable through a deliberate shift toward reducing carbon growth, ensuring effective environmental governance, and strategic investments in renewable energy systems that protects the continent's ecological and economic future. It was therefore recommended that policymakers should ensure forest conservation and land-restoration programmes, expand access to renewable energy, and institutionalise environmental governance frameworks in conformity with the African Union's Agenda 2063 and the African Green Growth Strategy mechanisms

Keywords: Sustainable Development, Environmental Degradation, Renewable Energy, Governance, Africa



Reimagining sustainability pathways: Evaluating carbon dioxide fluxes under conservation agriculture in a semi-arid Eastern Cape, South Africa

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Abstract

Carbon dioxide (CO₂) is the most dominant anthropogenic greenhouse gas, primarily because it persists in the atmosphere for centuries. Climate change poses significant challenges to global food security and agriculture by negatively affecting production, thereby hindering progress towards achieving the United Nation's Sustainable Development Goals (SDG) 1 (No Poverty) and 2 (Zero Hunger). Although agriculture is essential for global food security, it is under increasing pressure to reduce greenhouse gas emissions with sectorial climate mitigation efforts adding further pressure. Conservation agriculture (CA) has received increasing worldwide attention to mitigate challenges associated with conventional tillage. This system is associated with reducing soil degradation and sustain crop yields, in line with SDG 1 and 2. Beyond these benefits, CA may also lower fossil fuel demand in farming operations, while influencing soil-atmospheric CO₂ fluxes - an area still underexplored in semi-arid African contexts. This study aims to evaluate the influence of CA on CO₂ fluxes in a semi-arid region in the Eastern Cape, South Africa, contributing to SDG 13 (Climate Action) by promoting climate resilient farming practices. The primary objective was to assess temporal shift in CO₂ emissions by comparing 3-year and 12-year phases of an ongoing long-term CA trial.

The study was conducted on an ongoing CA trial at Phandulwazi Agricultural High School in the Eastern Cape, South Africa. The CA trial was established in 2012 using a split-split plot design with 16 treatments replicated across three blocks. Tillage [conventional tillage (CT) and no-till (NT)] was the main plot, crop rotation [Maize-fallow-maize (MFM), maize-fallow-soybean (MFS), maize-wheat-maize (MWM), and maize-wheat-soybean (MWS)] the sub-plot, and residue management [removed (R⁻) and retained (R⁺)] the sub sub-plot. Monthly CO₂ emissions were measured *in situ* using an automated LI-COR gas analysis system. Soil sampling was carried out during summer and winter of the 2024/25 growing seasons to analyse selected chemical parameters (i.e., soil organic carbon, active carbon, microbial biomass carbon, pH, electrical conductivity and soil respiration).

Findings of this study provide empirical insights into CO₂ emission trends between 3- and 12-year phases of an ongoing CA trial, as well as the balance between emitted and stored carbon. A significant four-way interaction (tillage x crop rotation x residue management x month) revealed elevated CO₂ fluxes in November, particularly at CT and R⁻ (reaching 3.7293 μmol·m⁻²·s⁻¹). This peak in CO₂ emissions coincided with higher moisture content (31.990%) in November. A significant interaction between tillage and residue management (p = 0.0163) confirmed that CT and R⁻ consistently resulted in higher CO₂ fluxes. In contrast, lower CO₂ emissions were observed in May, approximately six months after tillage. Overall, the results highlight the potential of CA in restoring the balance between soil and atmospheric carbon, offering pathways relevant for smallholder farming systems and climate change mitigation.



Incorporating CA strategies in semi-arid regions helps in addressing the interconnected challenges of climate change, food security and poverty. By situating CO₂ fluxes within long-term trials, this study frames CA as central to reimagining sustainability pathways for agriculture – where innovation in practice, policy, and research converge to address climate, food security and livelihoods.

Keywords: carbon dioxide flux, climate change mitigation, crop residue management, crop rotation, no tillage



Ecological restoration and carbon emissions: Trade-offs in restored and degraded Mistbelt forests of the Eastern Cape

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Abstract

Greenhouse gas emissions are a major global environmental concern and key drivers of climate change, posing a barrier to achieving sustainable development goal (SDG) 13 (Climate action). Forest degradation accelerates carbon dioxide (CO₂) emissions, further contributing to changes in climate conditions. In contrast, restoration practices have been shown to reduce net CO₂ losses to the atmosphere and to return the functioning of the forest as carbon sinks, supporting SDG 15 (Life on land). However, forest restoration with new plant species may influence hydrological processes and potentially alter CO₂ fluxes. This highlights the need for restoration strategies that enhance soil fertility and water regulation, thereby supporting sustainable agriculture and food security (SDG 2: Zero hunger). Southern Mistbelt Forests can be considered to represent a major indigenous carbon store with considerable differences between primary and secondary forests and are important for biomass assessments to determine their carbon stocks

The study aims to monitor the effect of ecological restoration efforts on carbon emission on degraded Mistbelt forests in the Amathole region, offering one of the first insights into carbon–restoration trade-offs in South African montane ecosystems.

Monitoring the effects of ecological restoration on monthly/seasonal carbon dioxide fluxes and their relationship with management practices and other related soil properties.

The study measured CO₂ fluxes in restored and reference Mistbelt forest sites in the Eastern Cape, South Africa. Monthly CO₂ flux measurements were conducted using a 2 × 3 × 3 factorial design with three replications. Factors included two management types restored (R⁺) and reference (R⁻); three sites Swallowtail (S1), Madonna & Child (S2), and Zingcuka (S3); and three slope gradients flat (G1), gentle (G2), and moderate (G3). Quadrat sampling was used, and soil samples were collected from the 0–30 cm depth. A LI-COR 8100A automated soil CO₂ flux system was used for measurement.

A significant three-way interaction (R × S × M; $p < 0.05$) indicated that CO₂ fluxes varied jointly with management, site, and month, reflecting strong spatial and temporal controls on soil respiration. Within this interaction, elevated CO₂ fluxes were observed at S2 under R⁻ (29.04 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$), while a pronounced peak occurred at S1 under R⁺ (50.19 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$). At S2, CO₂ fluxes were consistently higher under R⁺ than R⁻, whereas at S1 and S3 the magnitude and direction of differences varied over the monitoring period. The R × M interaction further showed that R⁺ generally exhibited higher CO₂ emissions than R⁻. For instance, in October 2024, R⁺ recorded 14.78 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ compared to 10.50 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ in R⁻. In contrast, during early 2025, R⁻ showed slightly higher fluxes than R⁺, with differences of -1.09 and -2.25 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$. These variations are likely associated with changes in soil moisture, temperature, and organic matter inputs linked to restoration practices.



Overall, the results demonstrate that ecological restoration significantly influences CO₂ flux dynamics, with R⁺ generally exhibiting higher soil CO₂ emissions than R⁻, highlighting the importance of evaluating carbon trade-offs in restoration efforts.

Forest restoration plays a vital role in conserving biodiversity, combating desertification, preventing habitat loss, and ensuring sustainable land use, aligning with SDG 15 (Life on land). Addressing climate action (SDG 13), restored ecosystems enhance resilience, mitigate climate change, and reduce community vulnerability to climate-related hazards and natural disasters. By linking ecological restoration with climate resilience, this study frames forest restoration as a reimagined sustainability pathway that bridges research, practice and policy for long-term sustainable development.

Keywords: Carbon dioxide; Net ecosystem exchange; Slope gradient; Species restoration



Advancing Social Equity and Sustainable Development: Analysing the Inclusivity of Community-Level Irrigation Schemes in Zimbabwe's Limpopo Basin

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Abstract

This study examines the repercussions of the Manjinji community's exclusion from the Manjinji pan aquifer, a crucial water source for their livelihoods. The resulting deprivation has precipitated a crisis, underscoring the need for the rehabilitation of inclusive irrigation schemes that enhance the participation and empowerment of rural women in accessing essential resources. This qualitative research involved in-depth interviews with 26 participants (22 men and 4 women) from a total of 136 participants, comprising 112 women and 24 men, alongside focus group discussions with 90 individuals (88 women and 2 men). The investigation delves into community perceptions, lived experiences, and insights while also incorporating observational data on crop production, irrigation infrastructure, and management practices to enrich the understanding of behavioural patterns and phenomena. Findings indicate that, contrary to traditional patriarchal structures prevalent in irrigation schemes, the Manjinji initiatives have reconfigured power dynamics, significantly empowering women—who have historically been marginalized. The incorporation of the Manjinji pan into Gonarezhou National Park by the Zimbabwean government has severely curtailed women's access to vital livelihood resources. In response to these challenges, along with the adverse effects of climate change, development partners have revitalized a 60-hectare irrigation scheme, fostering women's leadership amid a growing disillusionment with male leadership, which has thus far failed to safeguard their interests. This transition has led to women assuming prominent leadership roles in managing the irrigation scheme, with diminished trust in their male counterparts. This study concludes that community-level irrigation schemes can serve as effective mechanisms for promoting social equity and resource access when managed adeptly. By prioritizing the needs and agency of women and marginalized groups, these schemes challenge existing disparities and empower previously disenfranchised populations. The findings advocate for participatory governance, transparent decision-making, and equitable resource redistribution to bolster resilience in climate-affected regions, contributing to broader discourses on social justice and sustainable development.



Unravelling the Buzzkill: Multifactorial Causes of Worldwide Honeybee Population Decline

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Abstract

Honeybees (*Apis mellifera* L.) are indispensable pollinators underpinning food security, biodiversity, and ecosystem resilience. However, their population has been significantly declining over the past four decades, threatening agricultural productivity and ecological stability. The drivers of this decline have been identified as multifactorial, arising from interaction abiotic and biotic stressors that disrupt honeybee physiology, immunity, and colony dynamics. Despite extensive research on honeybees, knowledge gaps persist regarding how these stressors intersect across geographic, climatic, and management contexts, particularly in underrepresented regions such as Africa and South America. This decline further reveals a growing disconnect between agricultural intensification and sustainability commitments under the United Nations Sustainable Development Goals (SDGs), notably SDG 2 (Zero Hunger) and SDG 15 (Life on Land), which advocate for food security and biodiversity conservation. In order to achieve sustainable agroecosystems, it is imperative to address the interaction of environmental, biological, and anthropogenic stressors.

The study aims to systematically synthesise and contextualise experimental evidence on the global decline of honeybee population, highlighting the multifaceted factors that shape colony health and resilience.

The objectives for the study were: (1) to systematically review peer-reviewed experimental and observational studies on honeybee population decline published between 1982 and 2025, (2) to classify evidence across five major stressor domains; pesticides, parasites/pathogens, climatic variability, nutritional stress, habitat degradation, and multifactorial interaction, (3) to identify emerging research frontiers, regional gaps, and mitigation strategies aligned with SDGs and climate-smart agriculture.

This systematic review was conducted in accordance with the PRISMA 2020 guidelines to synthesise empirical evidence on abiotic, biotic, and synergistic stressors contributing to honeybee (*Apis mellifera*) population decline. Literature searches were performed across Google Scholar, PubMed, Scopus, and Web of Science, supplemented by manual screening of reference lists. English-language studies published between 1982 and 2025 were considered. Following duplicate removal and multi-stage screening (title, abstract, and full text) based on predefined inclusion and exclusion criteria, 50 peer-reviewed experimental and quasi-experimental studies were retained. Structured data extraction captured stressor type, experimental design, response biomarkers, and geographic context. A descriptive and thematic synthesis was applied to examine stressor interactions, temporal shifts in research focus, and methodological evolution across decades.

The results indicated that honeybee decline results from synergistic rather than isolated stressors. Pesticides amplify pathogenicity of *Varroa destructor* and *Nosema ceranae*, while climatic



extremes and forage scarcity increase nutritional and immune stress. Before 2017, studies relied on field observations and toxicity assays, primarily focusing on single-stressor effects. In contrast, studies published after 2017 show a shift toward molecular, microbiome, and RNA-based approaches, advancing understanding of host-pathogen-environment dynamics. To date, research remains concentrated in Europe and North America, with limited representation from Africa, South America, and Oceania, calling for temporal assessments that capture seasonal and multi-year colony trends.

The findings emphasise integrating honeybee health into broader sustainability and climate-adaptation agendas. Climate-smart agriculture practices such as diversified cropping, reduced synthetic agrochemical inputs, and pollinator-friendly habitat offer practical solutions to enhance colony resilience. Aligning honeybee conservation with SDG 2, SDG 13 (Climate Action), and SDG 15 establishes a holistic framework for sustaining agroecosystem productivity and ecological stability. By linking honeybee health to agricultural innovation, this review contribute to reimagining sustainability pathways that integrate research, practice, and policy for resilient systems.

Keywords: abiotic stressors, biotic stressors, climate change, colony collapse disorder, pollinator health, pollination services

School-to-work transition research in South Africa: A systematic literature review (1980–2025)

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Abstract

South Africa continues to experience persistently high unemployment, which affects not only graduates from higher education institutions but also their effective integration into the labour market. This paper systematically reviews school-to-work transition research in South Africa, examining dominant trends, thematic emphasis, and key lessons emerging from the literature. The motivation for the study was to understand the school-to-work transition processes is critical for strengthening higher education outcomes and improving labour market integration within the South African context. A systematic literature review was conducted covering published studies between 1980 and 2025 from two leading databases (Scielo SA and Sabinet SA publications). The PRISMA technique was used to systematically select the studies guided by a stipulated criterion. Thematic analysis was then used to analyse trends in the selected studies. Five key findings emerge from the synthesis of the reviewed studies. First, there is a strong empirical consensus on the existence of an employability skills gap, with graduates often perceived as insufficiently prepared for labour market demands. Second, higher education institutions are positioned as the primary site of transition, with limited attention given to non-university pathways. Third, individual psychological and career-related attributes play a significant role in shaping transition outcomes. Fourth, transition experiences are uneven and differentiated by institutional, disciplinary, and socio-economic factors. Finally, targeted developmental interventions, such as coaching, work-integrated learning, and career guidance, are consistently identified as beneficial in supporting transition readiness. Informed by the findings, the study identifies priority areas for future research, policy, and practice. It highlights the need to address enduring structural impediments that constrain effective alignment between education systems and labour market demands in South Africa. This paper represents one of the first comprehensive systematic reviews of school-to-work transition research in South Africa. The study advances understanding by emphasising the need for a more nuanced and coordinated approach to skills development, with proactive engagement from multiple stakeholders to enhance transition success.

Keywords: school-to-work transition; South Africa; skills development; labour market integration; systematic literature review



Towards a sustainable and integrated human settlement in the Buffalo City Municipality

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Abstract

The Integrated Sustainable Human Settlements Strategy (ISHSS) was introduced to address the gap in the housing service delivery in the Eastern Cape of South Africa. Additionally, the ISHSS seeks to address the legacy of apartheid-era spatial segregation by fostering socially integrated, economically viable communities through the development of diverse housing types, including subsidized, rental, and affordable housing. The Integrated Sustainable Human Settlements Strategy's primary goals are to eradicate informal settlements and accelerate housing delivery, social integration, and job creation. The main aim of this study is to evaluate the implementation of the Integrated Sustainable Human Settlement Strategy and examine the mechanisms adopted to implement ISHSS in the Buffalo City Metropolitan municipality. The study aims to identify the challenges of the integrated Sustainable Human Settlement Strategy. The Integrated Sustainable Development Strategy, however, is viewed as having a minimal impact on the distribution of housing provisions in the Eastern Cape, while leaving the majority of poor people still in need of a sustainable human settlement that also addresses inequality in service delivery. Housing service delivery is unstable due to systemic changes in South Africa's economic and political outlook. Therefore, this study aims to recommend strategies that can enhance the implementation of the ISHSS and sustain the provision of affordable, integrated human settlements. This study employed a qualitative research methodology to collect data using a purposive sample drawn from the population of Buffalo City Metro Municipality. The sample size of the study is 21 participants, which is aiming to avoid data saturation. The methodology used is compatible with the study's aim, and data were collected through semi-structured interviews, which allowed respondents to express their experiences fully. Data was thematically analyzed. The findings reveal that political interference within the municipality hinders the implementation of the Housing Strategy's progression aspect. The findings indicate that the inadequate financial budget allocated to the city is insufficient to meet the demand of the communities for implementing the housing strategy. This study also found that the BCMM meets the targets aimed at providing human settlements with healthy living conditions by providing safe living conditions and offering free houses to those with poor infrastructure. The study contributes to ensuring that municipalities work with relevant stakeholders to establish mechanisms for monitoring and evaluation.

Keywords: Buffalo City Metro Municipality, Housing delivery, Integrated Sustainable Human Settlements Strategy, Housing delivery, Informal Settlements, Political interference



Libraries as Evidence-Based Catalysts in Early Childhood Education in Nigeria

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Abstract

Early childhood education (ECE) in Nigeria faces persistent challenges including inadequate infrastructure, limited access to quality learning materials, and insufficient teacher training. Amid these constraints, libraries emerge as evidence-based platforms that can significantly enhance early learning outcomes. This abstract explores the transformative role of libraries in supporting ECE through research-backed interventions, community engagement, and resource accessibility. Libraries in Nigeria, particularly public and school libraries, serve as inclusive spaces where children can access age-appropriate books, storytelling sessions, and interactive learning tools. Empirical studies affirm that early exposure to print-rich environments fosters cognitive development, language acquisition, and social-emotional growth. Libraries also support caregivers and educators by offering professional development resources and parenting guides aligned with national education goals. Despite their potential, Nigerian libraries face systemic limitations including poor funding, lack of trained personnel, and minimal integration into ECE policy frameworks. To harness their full impact, stakeholders must adopt evidence-based strategies that embed libraries into national education planning, invest in capacity building, and promote community ownership. In conclusion, libraries in Nigeria are not merely repositories of books but dynamic, evidence-based agents of change in early childhood education. Their strategic utilization can catalyze holistic child development, reduce learning disparities, and contribute to achieving Sustainable Development Goal.

Keywords: Libraries, Early Child, Education, Community engagement, Nigeria



Sustainable Development and Housing Affordability

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Abstract

Europe is currently facing one of its most serious social problems—the declining affordability of housing. Rapid urbanization, rising energy costs, and ambitious climate goals are increasingly conflicting with the basic need to provide ordinary families with a roof over their heads. This conflict is particularly evident in Poland. The country has one of the highest rates of home ownership in the EU (over 85%), largely due to mass privatization after 1989. In this article, we analyze how sustainable construction requirements affect the affordability of housing. The key measure here is the price-to-income ratio (PIRI), i.e., how much annual household income is needed to purchase an average home. We rely on standardized OECD data and national statistics from the National Bank of Poland and the Central Statistical Office. We compare the situation in Poland with its Central European neighbors (the Czech Republic, Slovakia, Hungary, and Romania) and with more mature Western markets (Germany and Austria). The results leave no room for doubt: since 2015, Poland's PIRI has risen by 82%, reaching 10.6 in the third quarter of 2025. This is well above the OECD crisis threshold (>9) and the second worst in the region. Transaction prices in Warsaw have quadrupled in nominal terms since 2000, while the supply of new apartments has practically stagnated – in the first nine months of 2025, approximately 145,000 units were completed (a decrease of 1.1% y/y). One of the main culprits is the nearly zero-energy building (nZEB) standards, mandatory since 2021, which increase construction costs by 10-15%. In conditions of limited supply, the additional costs are passed on in full to buyers. Demand-stimulating programs, such as the “Safe 2% Loan,” paradoxically drove prices up further (PIRI +0.8 points after introduction), partially offsetting long-term energy savings of 20-40%. The study therefore highlights a difficult dilemma: environmental progress can exacerbate social inequalities if it is not accompanied by well-coordinated policies. We therefore propose shifting the focus to supply-side solutions—subsidized green rental housing, mandatory affordable housing quotas (at least 20% in new developments), and quarterly monitoring of PIRI. In the future, it would be worth examining the impact of nZEB on different income groups in more detail—this could help to develop more equitable solutions.

Key words: housing affordability, price-income ratio, sustainable construction, sustainable development, housing policy, Poland.



Reimagining Directors' Duties in Development Finance Institutions: Governance Innovation as a Pathway to Sustainable Development in Africa

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Abstract

Development Finance Institutions (DFIs) play a central role in financing Africa's green transition and advancing sustainable development objectives, in line with the United Nations Sustainable Development Goals. DFIs are uniquely positioned to support long-term developmental outcomes. The governance role of DFI boards and the interpretation of directors' duties within these institutions are largely understudied in sustainability and development finance scholarship. The core problem addressed in this paper is the absence of a clear governance framework explaining how directors' duties can be interpreted and applied in DFIs without constraining long-term, sustainability-oriented decision-making through overly narrow, risk-averse conceptions of fiduciary responsibility. This paper examines how DFI boards can function as governance enablers of responsible innovation for sustainability, as opposed to purely taking on a compliance and risk oversight role. It argues that traditional, risk-averse interpretations of fiduciary duties may inadvertently constrain DFIs' developmental mandates, by reducing director's duties to procedural compliance. Methodologically, the paper adopts a doctrinal and normative legal research approach. The doctrinal method involves an analysis of directors' duties as provided for in the Companies Act 71 of 2008 and interpreted through relevant corporate governance frameworks, including the King IV Report on Corporate Governance. This is complemented by a normative evaluation of these duties in light of sustainable finance principles, development finance objectives, and emerging governance expectations applicable to DFIs. The paper proposes a model of "catalytic stewardship", in which DFI boards are understood as stewards of financial integrity and developmental impact. A purposive and governance-oriented interpretation of directors' duties grounded in duties of care, skill, diligence, and good faith can support long term investment decisions, while promoting integrated oversight of climate and sustainability-related financial risks. The paper contributes to emerging debates on sustainable finance and institutional governance by clarifying the role of directors' duties in DFIs and offers practical insights for policymakers, DFI boards, and governance practitioners seeking to strengthen accountability frameworks for sustainable development in Africa.

Keywords: development finance institutions, directors' duties, corporate governance, sustainable finance, stewardship theory.



Developing a sustainable climate-resilient economic growth and development model for Rwanda

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Abstract

Rwanda has been at the forefront of sustainable development in Africa, striving to achieve a green, climate-resilient, and low-carbon economy by 2050. This ambition reflects the country's dedication to addressing the dual challenges of climate change and economic development. This study examines Rwanda's Climate Resilience and Economic Development, focusing on how national efforts align with SDG 13 (Climate Action) and SDG 15 (Life on Land) in order to address climate challenges such as rising temperatures, erratic rainfall, and environmental degradation. Using a quantitative panel data approach, the research analyses the relationship between economic growth (measured by GDP growth), climate resilience investments, ecosystem-based adaptation initiatives, and climate finance flows, while controlling for key macroeconomic and institutional factors. The study is expected to generate empirical evidence on how climate-resilient policies and green investments contribute to stable economic growth while enhancing ecosystem integrity and reducing climate vulnerability. It proposes a policy-oriented development model that balances economic expansion, environmental sustainability, and social resilience. By contextualizing global climate-resilient development theories within Rwanda's development trajectory, the research contributes to both academic literature and national policy formulation. The study will adopt a quantitative research design using time-series and panel data covering macroeconomic indicators, climate resilience strategies, ecosystem-based adaptation measures, and climate finance flows. Key variables will include GDP growth, climate-resilient investments, ecosystem conservation indicators, renewable energy adoption, and relevant socio-economic and institutional control variables. Econometric techniques such as regression analysis, fixed and random effects models, and robustness tests will be employed to examine the relationship between climate resilience interventions and economic growth and development outcomes in Rwanda. The expected outcome of the research is the formulation of an integrated sustainable climate-resilient economic growth model that demonstrates how climate-smart policies can simultaneously enhance economic performance, reduce vulnerability to climate risks, and protect natural ecosystems. The study will provide empirical evidence on the effectiveness of climate resilience strategies in promoting long-term development and inform policy decisions on green investment, climate finance mobilization, and institutional coordination. Ultimately, the research will contribute to Rwanda's national development agenda and support progress toward the Sustainable Development Goals, particularly SDG 13 (Climate Action) and SDG 15 (Life on Land), by offering a practical framework for achieving resilient, inclusive, and sustainable economic growth. The findings will provide actionable insights for policymakers, development partners, and financial institutions on designing integrated strategies that promote sustainable, climate-resilient, and inclusive economic growth in Rwanda.

Key words: Climate resilience, economic development, economic growth, SDG13, SDG15



Gender Inequality and Female Unemployment in South Africa: A Macroeconomic and Sustainable Development Perspective

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Abstract

South Africa continues to experience persistently high unemployment, with women disproportionately affected. This study examines the structural link between gender inequality and female unemployment within a macroeconomic context of slow growth and weak job creation. Using secondary data from Statistics South Africa, the World Bank, and UNDP (1990–2023), regression and ARDL models were employed to assess the impact of GDP growth, inflation, human development, and gender inequality on female unemployment. The results indicate that higher GDP per capita and improvements in human development lower female unemployment, while inflation and gender inequality increase it. Integrating national evidence with township-level studies highlights how limited skills, care responsibilities, and transport barriers intensify women's joblessness. The findings underscore the need for gender-responsive macroeconomic policy and targeted interventions addressing occupational segregation and care infrastructure to enhance women's participation in South Africa's labour market. Beyond its social justice implications, persistent female unemployment constrains South Africa's progress towards inclusive and green growth, undermining SDG 5 (Gender Equality), SDG 8 (Decent Work and Economic Growth), and the country's 'just transition' ambitions. Using secondary macroeconomic data for South Africa, the study examines the relationship between female unemployment and gender inequality, alongside key macroeconomic indicators—GDP per capita, inflation, and the Human Development Index (HDI). The analysis employs correlation and regression techniques (with an autoregressive distributed lag approach used to accommodate dynamics), and situates the results within feminist economics, human capital theory, and labour market segmentation frameworks. Findings suggest that higher gender inequality is associated with higher female unemployment, while improvements in human development and income levels are associated with lower female unemployment. The paper concludes with policy and managerial implications that emphasise gender-responsive macroeconomic and labour market policies, targeted skills and employment interventions (including green and care-economy job pathways), and stronger institutional mechanisms to reduce structural barriers facing women.

Keywords: Female unemployment, Gender inequality, Human development, Labour market, South Africa, Just transition



The Applicability Of Strategic Entrepreneurship (SE) Concept To Sustainable Urban Development (SUD)- Cape Town, South Africa.

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Abstract

The chapter analyse the linkage of strategic entrepreneurship and sustainable urban development. It evaluates how entrepreneurial techniques can be critical mass in promoting long-term urban sustainability. Strategic entrepreneurship is a concept that brings together the opportunity-seeking and advantage seeking behaviours, providing a framework for inventive, flexible, and resource-efficient urban solutions. It provides an astute a way of tackling urban sustainability issues. Sustainable urban development (SUD) is an important global concept that necessitates innovative solutions causal to economic growth, environmental sustainability, and social welfare. This study interrogates the role of SE in cultivating sustainable urban environments through the analysis of the contribution to advancing green technology, improving resource efficiency, and facilitating inclusive economic development. Since this study is literature-based, it follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. The essential entrepreneurial techniques that foster resilient and sustainable cities through an examination of case studies and existing literature are out-lined. The results superimpose the necessity for supporting policies, inter-sectoral cooperation, and creative business models to effectively utilise social enterprises for sustainable urban change. In addition, results also indicate that strategic entrepreneurship improves the adapt-ability and sustainability of urban growth, making it a feasible method for future city planning. Theoretically, the study shows the relevance of SE in cultivating sustainable urban environments by analysing its contribution to advancing green technology, improving resource efficiency, and facilitating inclusive economic development. Practically, the study recommends essential entrepreneurial techniques that foster resilient and sustainable cities through an examination of case studies. It also presents significant insights for politicians, urban planners, and entrepreneurs aiming to incorporate strategic entrepreneurship into sustainable urban development frameworks.

Keywords:

Strategic entrepreneurship, Sustainability, Urban development, Support, Planning



The Government's Technical Support Mechanisms For The Business Sustainability Of The Beef Cattle SME Sector In Zimbabwe.

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Abstract

This study critically evaluates the effectiveness of government technical support for beef cattle SMEs in Zimbabwe. It reviews key support mechanisms, including extension services, training programs, veterinary assistance, and technology access, assesses their real-world impact, identifies barriers to utilisation, and proposes strategies to enhance productivity and sustainability in the sector. A qualitative design was employed, drawing on interviews with 311 beef cattle SME operators in Makonde and Zvimba districts (Mashonaland West) selected through convenience sampling. Findings indicate that while support structures exist, their effectiveness is weakened by bureaucratic delays, limited outreach, and resource constraints. The study offers actionable insights for policymakers aiming to enhance support frameworks and promote sustainable SME growth. Strengthening technical support policies, promoting stakeholder collaboration, and investing in targeted capacity-building can enable SMEs to navigate a rapidly changing agricultural landscape better, build sectoral resilience, and contribute to broader economic development in Zimbabwe.

Key words: Beef SMEs, Technical support, Sustainability, Policy, Agriculture



The damming of rivers: Re-imagining water ethics in Lesotho

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Abstract

The construction of dams along rivers signifies one of the most significant yet ethically contentious dimensions of human advancement. While originating from ancient methodologies of water governance and regulation, the extensive construction of dams surged during the twentieth century, fundamentally transforming both landscapes and societies under the auspices of progress and sustainability. In Lesotho, the expansion of dam construction projects has raised important discussions about whether these projects genuinely support sustainable development. Beyond causing significant disruption to river ecosystems, these projects have brought sustained ecological and financial insecurity to the impacted communities. This article offers a fresh perspective on water ethics in Lesotho by examining the moral and development-related challenges associated with river dam construction. The article argues that a truly sustainable water governance must go beyond simplistic cost–benefit analyses and adopt a community-centric ethic that safeguards freshwater resources, promotes social equity, and reconsiders human–nature interactions within a paradigm of ecological accountability and ethical guardianship with sustainable lens. Using the Lesotho Highlands Water Project as a case study, the article employs a systematic qualitative methodology rooted in ethical theory and development critique to reimagine water ethics in Lesotho

Keywords: community-led development, damming of rivers, Lesotho highlands, sustainable development, water ethics and governance.



Sustainable Corrosion Mitigation Of Mild Steel Utilising Ficus Thonningii Leaf Extract

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Abstract

This study explores the corrosion inhibition efficiency of Ficus thonningii leaf extract as an environmentally benign inhibitor for mild steel in 1 M Sulphuric acid environment through electrochemical, spectroscopic, and surface morphological analyses. Phytochemical analysis confirmed that the leaf extract contained flavonoids, tannins, alkaloids, saponins, and phenolics compounds well-known to develop stable complexes with metal surfaces through π -electron and lone-pair interactions. Fourier Transform Infrared Spectroscopy (FTIR) spectra revealed shifts and intensity reductions in O–H, C=O, and C–O bands after immersion, validating the sorption of phytoconstituents on the mild steel's surface via chemisorption and hydrogen bonding. The Open circuit potential (OCP) demonstrated that the corrosion potential shifted positively with inhibitor addition, and the Potentiodynamic polarization (PDP) studies showed that the corrosion current density (i_{corr}) reduced from 5.32×10^{-2} A for the blank to 4.38×10^{-2} A at 800 ppm, leading to a significant reduction in corrosion rate from 3.17×10^3 to 2.01×10^3 mil/year. Nyquist and Bode plots showed an increase in charge-transfer resistance (R_{ct}) and reduced double-layer capacitance (C_{dl}) with higher inhibitor concentration, indicating enhanced barrier film formation. The X-ray Diffraction (XRD) patterns indicated suppression of α -Fe peaks and emergence of an amorphous phase, signifying surface passivation by the inhibitor. Scanning Electron Microscopy (SEM) and Energy Dispersive Spectroscopy (EDS) analyses showed that the inhibited surface exhibited fewer corrosion pits, smoother morphology, and enrichment in carbon and oxygen species, verifying protective film formation. The inhibition efficiency improved with increase in the extract's concentration achieving optimal performance at 800 ppm. These findings establish Ficus thonningii leaf extract as a sustainable, green corrosion inhibitor capable of enhancing the durability of mild steel in aggressive acidic environments.

Keywords: Ficus thonningii, Mild steel, Sulphuric acid, Corrosion inhibition, Protective film



Strategic Green Human Resource Interventions and Employee Performance in Zimbabwean SMEs

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Abstract

Strategic Human Resource Management (SHRM) plays a critical role in enhancing employee performance, sustainable innovation, and green entrepreneurship in resource-constrained organisations. This study examines the relationship between strategic green human resource interventions and employee performance in Zimbabwean small and medium-sized enterprises (SMEs). Using SCHARTS Investments, an agro-based SME in Shamva District, as a case study, the research adopted a positivist, quantitative, and correlational design. Data were collected using a structured questionnaire and were completed by 55 employees and analysed using SPSS version 30. The study was guided by Expectancy Theory, Goal-Setting Theory, and Herzberg's Two-Factor Theory, which explain how motivation, goal alignment, and workplace satisfaction influence employee responses to green Human Resource (HR) practices. Descriptive statistics, reliability analysis, Pearson correlation, and multiple linear regression were used to test the study hypotheses. The findings show that employee well-being initiatives were moderately associated with improved performance ($r = 0.42$, $p < 0.05$), while talent development practices, particularly sustainability-oriented training, had a strong positive relationship with innovation and productivity ($r = 0.53$, $p < 0.01$). The strongest association was observed between performance management systems and employee performance ($r = 0.65$, $p < 0.001$). Collectively, strategic green HR interventions explained 56% of the variance in employee performance ($R^2 = 0.56$). The study contributes to Green Human Resource Management (GHRM) scholarship in developing-economy contexts by demonstrating that strategically integrated HR practices have the potential to enhance innovation, retention, and organisational resilience.



The study recommends embedding environmental training, transparent performance management, and employee wellness initiatives within HR policies so as to support Zimbabwe's Vision 2030 and the United Nations Sustainable Development Goals (SDGs) 8, 9, and 13.

Keywords: Green HRM, sustainable entrepreneurship, employee performance, innovation, SMEs, Zimbabwe



Remittances and Foreign Aid as Drivers of Entrepreneurial Development in Africa: Does Financial Development Matter?

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Abstract

Entrepreneurship development is increasingly recognised for its potential to alleviate poverty and foster sustainable development. However, success rates vary widely across regions, often reflecting disparities in capital access. Amid ongoing debates about the effectiveness of external financial inflows in addressing these constraints, this study investigates the role of financial system development as a critical enabler for channelling external financial inflows into formal entrepreneurial activity in Africa. Utilising panel data from 20 African countries spanning 2006 to 2023, the analysis employs the System Generalised Method of Moments and Driscoll-Kraay fixed effects techniques to ensure robust empirical findings. Moreover, the long-term orientation of foreign aid is misaligned with the short-term capital needs of startups, and no evidence supports a synergistic relationship between foreign aid and financial institution development in stimulating entrepreneurship. The study also highlights institutional quality and economic growth as significant drivers of entrepreneurial development. Policy implications suggest that remittances and foreign aid, in isolation, are insufficient to catalyse entrepreneurship in Africa. Their effectiveness depends on the maturity of financial systems. Therefore, governments should prioritise strengthening financial infrastructure, regulatory frameworks, and governance by expanding credit access, reducing transaction costs, and improving financial intermediation.

Keywords: financial development, foreign aid, entrepreneurial development, migrant remittances



The Strategic Impact Of Current Government Policies On The Performance Of Beef Cattle Small And Medium Enterprises In Zimbabwe.

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Abstract

This study evaluates how current government policies shape the performance of Small and Medium-Sized Enterprises (SMEs) in Zimbabwe's beef cattle industry. It focuses on four key policy areas: land ownership, access to finance, market regulations, and infrastructure development. Using a quantitative approach, data were collected from 311 SME beef cattle farmers in the Makonde and Zvimba districts of Mashonaland West through convenience sampling. The beef cattle sector is a critical pillar of Zimbabwe's agricultural economy, contributing to national food security and economic growth. However, SMEs in the industry face unstable markets, scarce resources, and shifting regulatory demands. The findings provide actionable insights for policymakers seeking to strengthen existing frameworks and support sustainable SME growth. They also equip SME owners with a clearer understanding of the policy environment, enhancing their capacity to adapt within a rapidly evolving agricultural sector. Future research could explore comparative policy analysis, climate change adaptation, public-private partnerships in livestock development, and technological innovation in beef cattle SMEs.

Keywords: Government, Policy, SMEs, Beef cattle, Transformation



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DEVELOPMENT**



Innovation platform as strategic ecosystems initiative

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Executive Summary

Mining companies face rising sustainability and environmental, social and governance (ESG) expectations while needing to maintain operational continuity and prepare for long-term closure and social transition. This paper presents the design rationale and operating model of an Innovation Platform as a Strategic Ecosystems Initiative, developed in collaboration between Harmony Gold and the Institute for Technology and Society. Inspired by ecosystem succession, the platform uses a Nature Positive innovation driver to prioritise strategic ESG initiatives that mature into bankable projects, technology deployments, and multi-stakeholder partnerships. The platform strengthens integrated closure maturity by building a credible operational knowledge base, enabling post-closure land-use options, and supporting socio-economic transition planning. A practical case example from the platform portfolio illustrates how ecosystem partnerships and SMME participation can create durable community value beyond the life-of-mine.

INTRODUCTION

The global population crossed 8.2 billion. Our planet's resources are under immense pressure. The demand for resources is likely to continue to grow because of population growth, infrastructure growth in developing countries, urbanisation trends and the dependency on the consumption resources. At the same time, the supply of resources are likely to tighten due to the depletion of natural resources, increasing regulatory response to environmental factors and climate change, higher community demands on resource companies, technological challenges stemming from diminishing resource quality and accessibility and; the reliance on politically unstable regions.

It is critical to shift from conventional growth metrics to the “doughnut” model of balancing human needs within ecological boundaries. The consequences of inaction are significant. A recurring socio-economic risk in mining regions is the emergence of “ghost town” dynamics when mining activity declines or ceases. In many host communities, the mine functions as the dominant economic anchor, shaping employment, local procurement demand, municipal revenue stability, and the viability of small businesses.

When the operation scales down, these dependencies can trigger a cascading contraction where jobs are lost, secondary businesses fail, skilled residents relocate, and public services deteriorate. The result is not only economic decline but an erosion of community resilience and social stability, often accompanied by increased vulnerability and conflict risk. From an ecosystem (Amir, 2023) perspective, ghost town outcomes reflect a structural weakness: the local economy is configured as a single-industry system with limited diversification and low adaptive capacity. This is especially pronounced where local SMMEs are primarily reliant on mine procurement and where



infrastructure, skills development, and enterprise support are tightly coupled to operational needs rather than long-term regional value chains. Closure planning may address environmental rehabilitation and compliance requirements, but without deliberate economic transitioning mechanisms, communities remain exposed to a sudden demand shock at the end of life-of-mine as illustrated in figure 1.

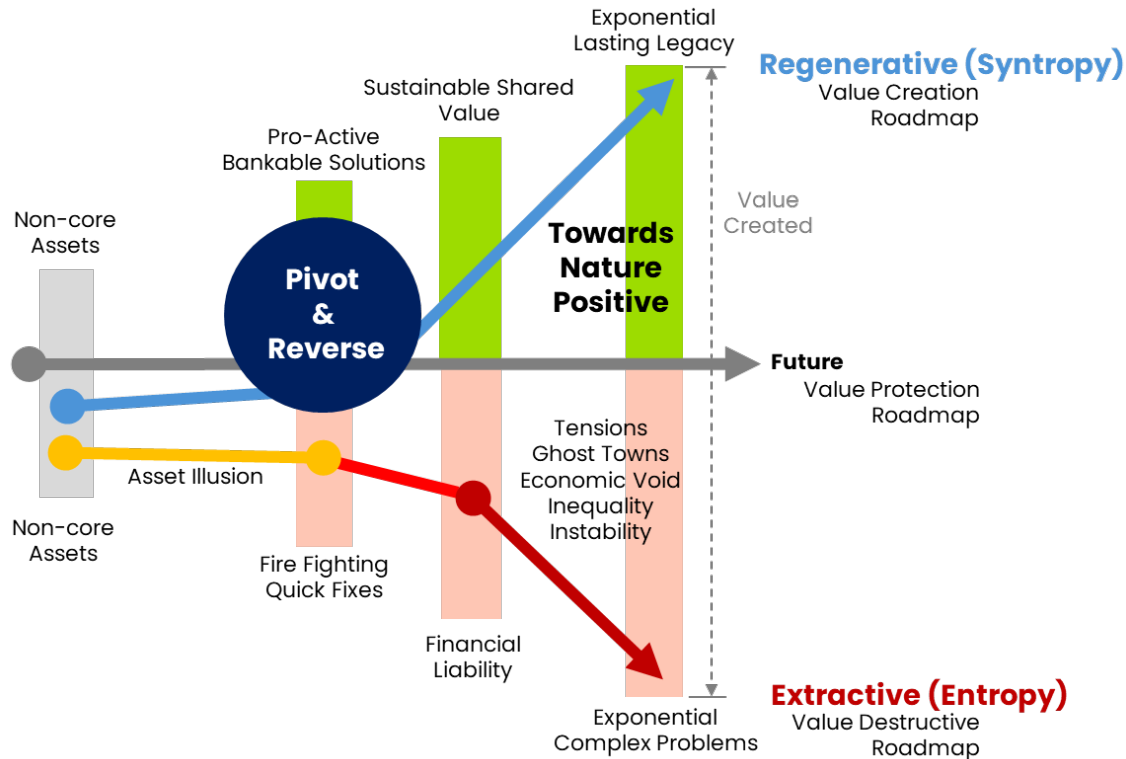


Figure 19: Towards regenerative, self-sustaining & thriving community ecosystems competitive on a global stage.

As this global landscape is evolving, companies are starting to see the same thing in a different way. Even though the process of mine closure and economic development is complex and integrated, sustainable development can be a source and driver of opportunity, innovation and even a competitive advantage.

As illustrated in figure 2, positioning the innovation platform as a strategic ecosystems initiative strengthens mine closure maturity by enabling a structured transition from extractive dependency to regenerative and diversified local value creation. During the operational period, the platform converts ESG and sustainability challenges (Nations, 2015) into bankable projects and partnerships that generate ongoing service demand beyond extraction.

Mine closure and socio-economic development are supported by extensive regulation and internationally recognised best practice (Disclosures, 2017); however, this work is intended to supplement these frameworks with a focused set of strategic projects that unlock greater value from Harmony's land, water, infrastructure assets and existing closure liabilities.



Closure is treated as a living, iterative process integrated into core mine planning, supported by progressive rehabilitation, fit-for-purpose end land use, and monitoring against agreed success criteria to enable long-term relinquishment.

**Socio-Economic
Dependency**

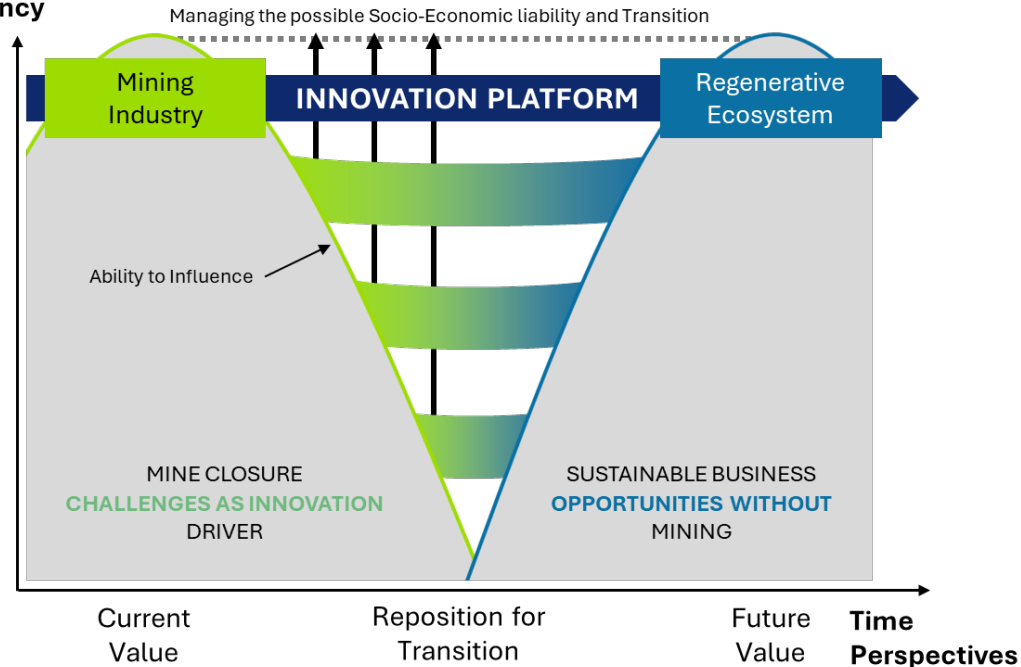


Figure 20: Innovation platform as strategic ecosystems initiative to manage social transitioning

Closure risk includes major social and economic transition liabilities (Ferraz), requiring early, coordinated investment and partnerships to build resilient post-closure local economies.

When guided by Nature Positive priorities and industrial symbiosis opportunities, the platform can expand local economic participation into areas such as water stewardship services, land rehabilitation and ecosystem restoration enterprises, circular waste-to-value systems, renewable energy operations and maintenance, environmental monitoring and reporting, and post-closure land-use development initiatives. This supports the creation of multiple interdependent economic “cells” that remain viable through and beyond mine closure.

INSPIRED BY NATURE

Sustainability is a journey rather than a destination. The Innovation Platform is inspired by ecosystem succession, where natural systems grow over time from simple early-stage conditions into complex, resilient, and self-sustaining ecosystems. In the roadmap (Jacobs, 2016), this idea is applied to sustainability innovation by showing a progression from current value activities to future value outcomes through successive waves of development.

The platform enables this transition across three linked layers: people and technology development, service and product development, and ultimately industry and market development.



As illustrated in figure 3, by providing continuity, governance and partner coordination, the Innovation Platform helps scale ESG initiatives beyond pilots into bankable projects and multi-stakeholder partnerships. The intended outcome is a regenerative and thriving community ecosystem that can sustain value creation beyond the life of the mine.

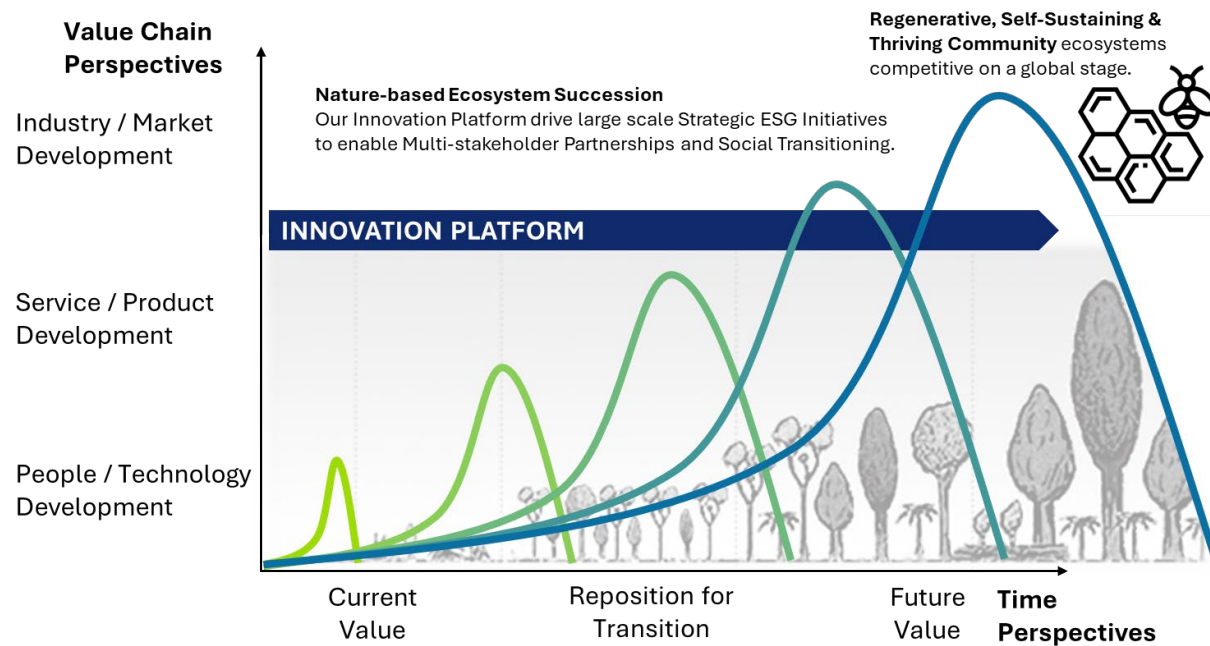


Figure 21: Inspired by Nature's ecosystem succession

The honeycomb (Ardley) metaphor is used to describe an SMME ecosystem where each enterprise forms a functional “cell” contributing a specialised capability (e.g., monitoring, maintenance, processing, rehabilitation) (Klewitz, 2014). When coordinated through the Innovation Platform, these cells interlock into a resilient local economy supported by shared standards, sustained demand, and partnership-enabled scaling.

SHAPING THE FUTURE INNOVATION PLATFORM

Purpose and Strategic Rationale

In collaboration with the Institute for Technology and Society, Harmony Gold Limited (Harmony) established the Shaping the Future Innovation Platform to roadmap and drive strategic ESG initiatives. This innovation platform enables multi-stakeholder partnerships in support of the sustainable development goals and social transitioning (Ghassim, 2018). The platform roadmapping process shown in figure 4 strengthens supply chains with technology to enable circular green economies.

The innovation platform represents a departure from traditional (business-as-usual) efforts, recognizing that novel approaches to address deep systemic issues are necessary to activate development opportunities within specific themes. The platform partners identify sustainable socio-economic development projects at scale that will unlock the full economic value of Harmony's land, water and redundant infrastructure and support their licence to operate.



These projects aim to create shared value and address Harmony's challenges associated with contaminated land, water offsetting, access to external funding, closure of certain liabilities, asset value increase, access to alternatives supporting sustainable people livelihoods and possible carbon tax reduction. Harmony and industry partners also have the option to integrate their existing Social and Labour Plan (SLP) and Corporate Social Investments (CSI) funded projects, as this strategic partnership ecosystem ensures the asset's value and enhance sustainability.



Figure 22: Strategic engagement to co-design and roadmap the Innovation Platform's Strategic ESG initiatives

Operating Model

This study applies an applied, systems-based operating model to describe how the Innovation Platform functions as a strategic ecosystems initiative (Sustainability, 2023) that converts sustainability ambition into implementable outcomes.

The platform drives strategic ESG Initiatives to enable multi-stakeholder partnerships and social transitioning. It aims to accelerate the development of regenerative ecosystems around mining operations by mobilising external investment, formalising partnerships and enabling innovation at different stratified project levels as illustrated in figure 5.

The platform is initiated through three input streams: prioritised ESG challenges emerging from operations and stakeholder expectations; closure maturity needs relating to rehabilitation, relinquishment readiness, and socio-economic transition; and enabling mine assets such as land, water resources, and redundant infrastructure that can unlock circular and post-closure opportunities.

Innovation delivery follows a structured stage-gate process, progressing from challenge definition and baseline setting to solution scouting, partner selection, piloting, and scale packaging.



Investment readiness is embedded throughout via feasibility screening, technical review, commercial structuring, and funding mobilisation to ensure initiatives can progress beyond pilots into execution.

The platform produces three primary outputs: (i) a portfolio of bankable projects aligned to strategic ESG priorities, (ii) strengthened SMME participation through interlinked local capability “cells,” and (iii) Measurement, Reporting and Verification (MRV) aligned metrics to support credible tracking of environmental, social, and operational performance outcomes.

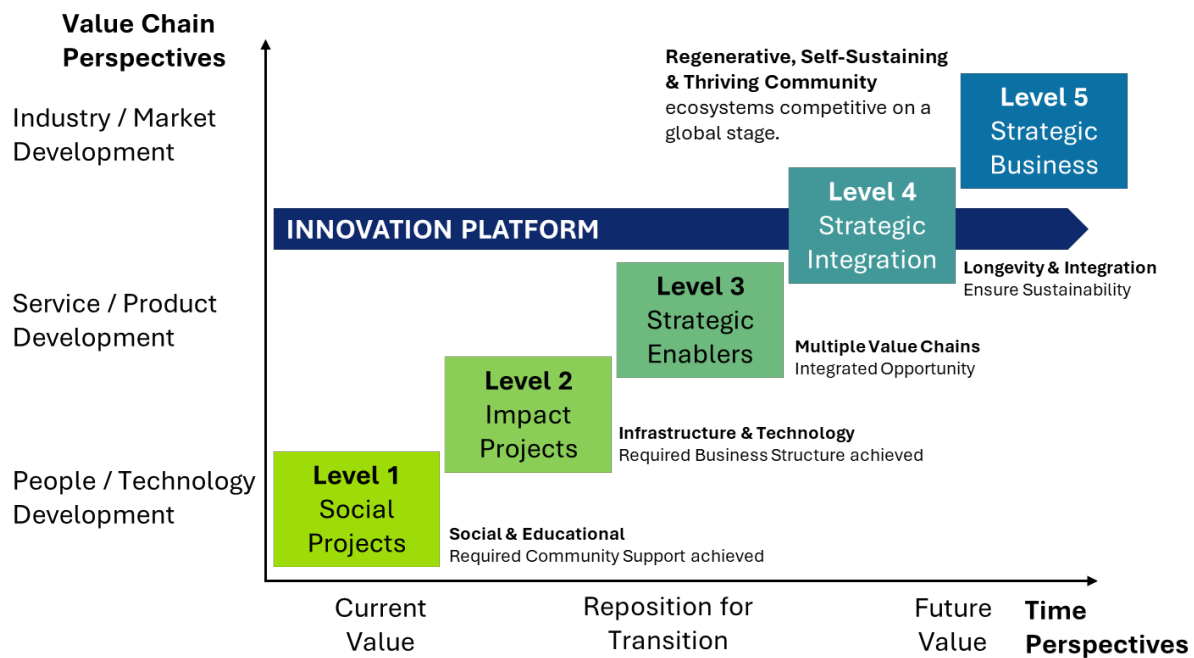


Figure 23: Mobilising external investment, formalising partnerships and enabling innovation at different stratified project levels

Value Contribution to Closure Maturity and Social Transitioning

The Innovation Platform strengthens integrated mine closure maturity by embedding closure planning into the mine business plan and aligning delivery to Harmony’s closure standard through structured governance, stage-gates, and cross-functional coordination.

It builds an evidence-based closure knowledge base during operations and supports feasible post-closure land-use planning through stakeholder engagement and regional alignment, enabling collaborative opportunities and reducing late-stage closure risk as shown in figure 6.



Activate Partnerships & Ecosystems	Integrate & Coordinate Ecosystems	Initiative & Innovation Management	Scaling & Knowledge Management
- Establish and co-chair ecosystem governance structures (e.g., regional steering committees, innovation councils). - Activate long-term partnerships with governments, donors, academia, NGOs, and industry.	- Design and manage cross-cutting innovation platforms that align local initiatives (e.g., agriculture, skills, infrastructure, SME development) into coherent, scalable systems. - Coordinate development across sectors to ensure strategic alignment with national/regional development plans.	- Integrate and oversee clusters of impact projects to optimize synergies, funding, and scale. - Support co-investment models (e.g., blended finance) by preparing projects for external funding pipelines.	- Apply systems thinking methodologies to map interdependencies across sectors and initiatives. - Facilitate continuous learning loops and cross-site innovation exchange within the organization.
Manage multi-stakeholder Engagement Strategies that ensure inclusive, Participatory Planning.	Develop multi-year transition Roadmaps and value-chain strategies with public and Private Partnerships.	Co-Lead structured Engagement Programmes to demonstrate integrated System Outcomes.	Identify and scale innovations that have cross-sector applicability with Commercial Potential.

Figure 24: Core functions of the innovation platform

On the socio-economic side, the platform provides a practical mechanism to plan and deliver social and economic transition, including partnership development, co-owned assessments of future local economic activities, and the initiation of priority social projects that enable post-closure livelihoods. Regular cross-functional engagement ensures that transition risks and opportunities are continuously integrated into the closure plan.

To maximise socio-economic benefits and long-term sustainability from Harmony's water, energy, and land-use initiatives, planning and execution must be supported through strategic and funding partnerships. Consistent with ICMM mine closure guidance (Metals, 2020), effective collaboration is required across internal mine functions, between mining companies, across related industries, and with external stakeholders including government, NGOs, foundations, social enterprises, academia, and development agencies - to enable coordinated action "beyond the fence line" and strengthen collective impact.

Finally, the platform supports rational decision-making by helping balance the closure business case - weighing long-term ownership costs and liabilities against the feasibility, cost, and complexity of relinquishment, transfer, divestment, or third-party stewardship—thereby improving the likelihood of sustainable closure outcomes and successful transfer of residual responsibilities.

STRATEGIC ECOSYSTEMS INITIATIVE

People and Technology Development

We see the green economy as a catalyst for SMME growth. As a co-created factory-as-a-product, we are revolutionizing the way society will produce food, monetise energy, convert waste into resources and; collect- and treat water within the circular green economy. In combination with Agritourism it not only supports the economies, it also ensures that young people fully appreciate the value of quality food. Our Shaping the Future Innovation Platform undertakes applied research & development (R&D) for the wide benefit of society as shown in figure 7.



Figure 25: Food. Factory. Work applied research and development and certification centres at Universities

This strategic ESG initiative established certification centres with universities, project centres with corporates and economic development centres with communities. Our initiatives behave as superorganisms by leveraging the power of collective intelligence and collaborative social innovation.

Service and Product Development

Food Factories as a social business breathe life into our small towns, and have the added benefit of creating work, and providing wholesome local fruits and vegetables. This ecosystem developed bankable and scalable community wealth building recipes as shown in figure 8.

A pilot project evolved from its initial focus on tree planting in 2021 towards a comprehensive development ecosystem that aims to positively transform the lives of those living in Cradock. This Trees-in-Pots project in the Eastern Cape established 3 500 fruit and nut trees with supporting infrastructure as well as mentorship and training by the ITS. The project serves as a Mine Community Development Project as part of the commitments in the Social and Labour Plan towards socio-economic development.

After establishment, a local black woman-owned beneficiary, Emarikeni, was identified to take ownership of the project over three years. As part of the beneficiation agreement Emarikeni had to continue with local beneficiation, skills development as well as grow their local vendor base to ensure a self-sufficient and sustainable business. When listed in the strategic Food. Factories. Work initiative on the Shaping the Future Innovation Platform this project did not only survive, it flourished and the ecosystem is still growing.



Figure 26: Demonstrates potential to food production in local communities with our strategic Food. Factories. Work initiative on the Shaping the Future Innovation Platform

Regenerative Market (Ecosystem) Development

Emarikení developed a thriving market hub, supplying freshly harvested and agro-processed fruits and vegetables, fresh juices and healthy bread. Products are sourced both from the food factory's own production and from local farmers, strengthening local supply relationships and short value chains.

With facilitation by the Institute for Technology and Society (ITS), the multi-stakeholder partnership ecosystem supported Emarikení to strengthen beneficiation skills and diversify its product range. This growth contributed to broader collaboration and visibility through platforms such as the Karoo Food Festival, demonstrating how partnership ecosystems can stimulate local market development.

Through the Innovation Platform, Emarikení accessed a partner-enabled capability set including solar drying, processing technologies, and biochar kilns. Solar drying reduces moisture to preserve produce without chemical additives, while *Miscanthus* biomass (originally linked to rehabilitation) was processed to substitute coco peat as a growing medium.

These hybrid soil substrates incorporating biochar were also developed to support carbon sequestration outcomes, enabled through the ITS Future Leaders Academy and partnerships with local and international universities, with funding support from the Net Zero Nexus NPC Endowment Fund.



Figure 27: First place in Agro-processing recognition from the Eastern Cape Department of Rural Development and Agrarian Reform (DRDAR) and on national level the Agro-Processing certificate from Min. Thoko Didiza of the Department of Agriculture, Land Reform and Rural development in 2023.

As a result, Emarikeni achieved agreed performance criteria with Harmony related to downstream expansion and beneficiation. As shown in figure 9, the initiative received multiple forms of recognition, including the Chris Hani Woman Entrepreneur Awards, Top Entrepreneur Small Holder prize and first place in Agro-processing recognition from the Eastern Cape Department of Rural Development and Agrarian Reform (DRDAR). The team also received the national DALRRD Agro-Processing certificate in 2023.

These type of community wealth blueprints are modular, scalable and bankable. The Innovation Platform thus delivers value by activating partnerships and ecosystems, integrating and coordinating ecosystem delivery, managing innovation execution, and scaling outcomes through knowledge management for replication and impact.

SUMMARY AND FUTURE WORK

Sustainability is best understood as a continuous transformation journey, because organisations and communities progress at different speeds and under different local conditions. As a result, the most important factor is not the timeline, but the sequence and scale of interventions that enable lasting change.

Inspired by nature, the Innovation Platform follows the logic of ecosystem succession, building momentum from foundational capabilities, to scalable solutions, and ultimately to mature regenerative ecosystems that strengthen both environmental outcomes and community resilience over time.

The Innovation Platform for Sustainable Partnerships is positioned as a structured mechanism to advance long-term sustainability, circular economy opportunities, and ESG risk management in

the mining sector. Through strategic partnerships, an integrated governance, risk, and compliance (GRC) approach, and deliberate project preparation for funding, the platform supports Harmony Gold Limited in converting sustainability priorities into measurable initiatives and investment-ready programmes that contribute to an enduring environmental and social legacy. Aligned with SDG 17 (Partnerships for the Goals), the platform enables coordinated collaboration between industry, technology partners, finance institutions, government stakeholders, and communities.

Future work should focus on strengthening the platform's evidence base through longitudinal evaluation, including the conversion rate of pilots to bankable projects, the mobilisation of external investment, and verified measures of socio-economic transition outcomes. In addition, the open innovation challenge and annual engagement programme should be further developed as repeatable mechanisms for growing a sustainable partner ecosystem and accelerating scalable adoption across mine sites.

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Acknowledgements

The authors acknowledge contributions from Harmony Gold Limited and Net Zero Nexus NPC's operational teams, sustainability leadership, community stakeholders, and partner organizations involved.



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