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ABOUT JCBM

The **Journal of Construction Business and Management (JCBM)** is an open access journal published bi-annually by the University of Cape Town Libraries, South Africa. The Journal is hosted by the Construction Business and Management Research Group of the University of Cape Town. The journal aims to explore the experience of construction industry stakeholders and trends in the global system. It aims to publish peer reviewed and highly quality papers emanating from original theoretical based research, rigorous review of literature, conceptual papers and development of theories, case studies and practical notes. The journal also welcomes papers with diverse methodological research approaches including qualitative, quantitative, and mixed methods. Contributions are expected from academia, public administrators, professionals in the public sector and private practice (such as contracting organizations and consulting firms) and other related bodies and institutions (such as financial, legal and NGOs).

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Improving Business Resilience, Digital Readiness, Project Performance and Sustainable Construction in Emerging Markets

Editorial June 2026

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Introduction

Welcome to Issue 2 of Volume 8 of the *Journal of Construction Business and Management*. This issue brings together five papers that address important concerns in the practice of construction business and project management. The papers focus on project management performance, business survival, net-zero construction, digital transformation, and supply chain management. The studies show that construction performance depends on people, organisations, technology, finance, sustainability, and governance. They also show the need for practical strategies that can help construction organisations improve delivery, manage uncertainty, and respond to changing economic and environmental conditions. The articles in this issue were contributed by 20 authors from Nigeria, South Africa, and China. The studies are primarily set in sub-Saharan Africa construction contexts, proposing useful lessons for other emerging markets facing similar challenges

Discussion of the Papers

Sajuyigbe et al. (2026) examine the relationship between job satisfaction, project management training, and project management performance in the Nigerian construction industry. Their study shows that job satisfaction improves project management performance. It also shows that project management training enhances this relationship. The paper highlights the value of investing in both employee satisfaction and structured training. For managers and policymakers, the findings suggest that improved project performance requires a skilled and motivated workforce.

Moyanga et al. (2026) investigate strategies that quantity surveying consultancy organisations in Nigeria can use to survive economic turbulence. The study identifies three main groups of survival strategies: organisational development and innovation, merger and partnership, and business and marketing strategies. The paper shows that quantity surveying firms, especially small and micro-sized firms, operating in unstable economic environments need to improve service quality, be innovative, manage cash carefully, and consider partnerships where necessary.

Gyadu-Asiedu et al. (2026) present a bibliometric review of nature-based solutions and materials that support net-zero construction in South Africa. The study identifies key research themes, including circular economy approaches, sustainable building materials, energy efficiency, zero-carbon strategies, and embodied carbon in construction supply chains. The paper shows that nature-based solutions and sustainable materials can help reduce emissions and improve environmental performance. It also points to gaps in research, especially the limited representation of African contexts in global studies on net-zero construction.

Cloete et al. (2026) assess the readiness of facilities management organisations in South Africa to adopt Building Information Modelling. Using the Technology Readiness Index, the study finds a medium level of readiness. The results show high optimism and willingness of the organisations to adopt innovative technologies. The paper proposes a four-phase framework for BIM adoption comprising awareness, pilot, scale, and institutionalisation.

Nyalungu et al. (2026) examine how supply chain management affects project management outcomes. The study focuses on issues such as cost, time, quality, risk, and stakeholder satisfaction. The findings show that late payments, weak supply chain practices, poor planning, and management delays can affect project delivery. The paper stresses the need for stronger procurement systems and better staff training, which are important lessons for public sector project delivery and municipal infrastructure management

Conclusion

This issue of the *Journal of Construction Business and Management* advances knowledge on how construction organisations can improve performance in challenging environments. The papers show that better outcomes depend on training, innovation, strong business strategies, digital readiness, the use of sustainable materials, and the adoption of an effective supply chain system. A central message across the papers is that construction organisations must prepare for change. They must build skills, improve internal systems, adopt useful technologies, and respond to economic and environmental pressures. The studies also show that emerging markets need solutions that fit their own institutional, financial, and social conditions.

We thank the authors for their contributions. We also thank the reviewers for their careful assessments and the editorial board for their continued support. We invite readers to engage with the findings and encourage future submissions that enhance the understanding of construction business, sustainability, technology adoption, and project delivery in emerging markets

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Assessing the Mediating Role of Project Management Training on the Nexus between Job Satisfaction and Project Performance in the Nigerian Construction Industry

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Abstract

This study fills a critical gap in behavioral science by exploring the mediating role of project management training (PMT) in the relationship between job satisfaction (JS) and project management performance (PMP) within Nigeria's construction industry—a context rarely examined in prior research. Using a non-probabilistic sample of 250 professionals, with 208 valid responses, data were analyzed through structural equation modeling to test both direct and indirect effects. Results show that JS has a significant positive effect on PMP ($\beta = 0.250$; $p = 0.003$), while PMT strongly predicts PMP ($\beta = 0.833$; $p = 0.000$). Indirect effects analysis confirms that PMT partially mediates the JS–PMP relationship ($\beta = 0.295$; $p = 0.000$), meaning job satisfaction still enhances performance even when training is accounted for. This mediating role represents the study's key novelty, demonstrating that training amplifies but does not replace the influence of employee satisfaction on project outcomes. The findings emphasize that improving job satisfaction alone is insufficient for optimal project results. Targeted PMT equips workers to manage complex construction demands, boosting engagement and overall performance. Practically, the study provides actionable insights for managers and policymakers: integrating structured training programs with initiatives to enhance job satisfaction is essential for stronger project delivery and sustainable development within Nigeria's construction sector.

Keywords: Project management training, job satisfaction, project management performance, construction industry.

1. Introduction

The construction industry (CI) is a cornerstone of economic sustainability worldwide, generating vast employment opportunities for both skilled and unskilled workers and contributing significantly to national GDP. Globally, it underpins economic growth and infrastructure development (Al-Nabae & Sammani, 2021; Picciotto, 2020). For example, the sector accounts for about 7% of the UK's GDP and over 5% of the US GDP, employing roughly 8 million workers annually, or about 5% of the U.S. workforce. In Canada, it adds more than $140 billion to the economy each year, representing 8% of GDP (Anderson & Lannon, 2019). India's construction industry employs around 35 million people, generates assets worth about $250 billion, and contributes over 5% of GDP (Mahalingam & Nagarajan, 2018). In South Africa, it supports nearly 2 million jobs and contributes over $7.5 billion to GDP (South African Construction Industry Report, 2022). Kenya's sector provided about 6% of GDP in 2023, with around 245,000 formal jobs and extensive informal employment, representing 15.6% of national employment (Civil Engineering Market Reports, 2025). These figures highlight the construction industry's pivotal role in economic development, job creation, and infrastructure growth, making it a key driver of sustainable national and global economies.

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In Nigeria, the construction industry is a vital driver of economic growth and job creation, contributing over 4.5% to the country's Gross Domestic Product (GDP) (Emmanuel et al., 2020). In comparison, education contributes approximately 2.17%**,** manufacturing around 9%**,** and the financial sector, a key component of the services industry, accounts for over 50% of GDP. Micro, Small, and Medium Enterprises (MSMEs**)** contribute approximately 49–50% and are responsible for generating about 84% of national employment, highlighting their essential role in economic sustainability (Emmanuel et al., 2020). The construction sector's steady contribution reflects its central role in infrastructure development and urban expansion. Its performance directly affects multiple sectors, such as manufacturing, transportation, and real estate, making it a critical enabler of Nigeria's broader economic development goals.

The Nigerian construction industry is a vital engine of economic development, providing essential housing, infrastructure, and public works. Yet it faces a complex mix of risks and constraints that threaten productivity and worker safety. Bejide and Iyagba (2015) observe persistent shortages of skilled labour and heavy reliance on untrained workers, which reduce quality and cause delays. Regulatory bottlenecks, weak enforcement of building codes, and slow permitting further drive up costs and extend timelines. Financial pressures—high interest rates, inflation, and currency volatility frequently stall projects midstream. Supporting infrastructure such as power, transport, and water remains inadequate, complicating material delivery and site operations (Ekung & Adewuyi, 2018). Quality-control failures and substandard materials heighten the likelihood of structural collapse and workplace accidents. Corruption and political interference in contract awards inflate costs and erode investor confidence (Adeleke et al., 2020), while land-tenure disputes create additional delays. Many firms are slow to adopt modern construction technologies or sustainable practices, and the migration of skilled professionals abroad deepens the labour deficit.

These systemic weaknesses also endanger workers. Abrey and Smallwood (2014) report that over 40 % of work-related fatalities occur on construction sites, and Al-Sadi and Khan (2018) highlight high injury risks across the sector. COVID-19 amplified these problems, worsening labour shortages and disrupting projects worldwide (Emmanuel et al., 2020). Globally, over 80 % of construction projects fail before execution (Harrington & Frank, 2015), and industry leaders warn of a looming shortage of 100,000 skilled workers by 2029 (Çelik & Oral, 2021). In Nigeria, these pressures have contributed to job dissatisfaction, limited career growth, and declining project management performance (Yahaya, 2021).

Job satisfaction (JS) has been a central focus of research for decades across both developed and developing nations and is widely acknowledged as a key motivator influencing project management performance (PMP) (Masood et al., 2020). It plays a critical role in human resource management, shaping the attitudes and behaviors of construction site workers (Şimşek & Gürler, 2019). Usukhbayar and Choi (2020) found that satisfied project managers are more likely to foster a positive work environment that enhances PMP. Additionally, project management training (PMT) is identified in HR literature as a powerful motivational tool that can significantly influence project outcomes (Çelik & Oral, 2021). PMT equips professionals with the necessary competencies, tools, and methodologies to meet project requirements and deliver results on time and within budget (Ni et al., 2022). Zhao et al. (2020) further emphasize the impact of diverse project management skills on overall project success.

The integration of PMT and JS is vital for the construction industry's role in achieving the Sustainable Development Goals (SDGs), particularly those related to sustainable urban development and inclusive opportunities by 2030 (Zhao et al., 2020; Daoor et al. 2020; Akhund et al., 2019). Hutajulu (2020) underscores the importance of both PMT and JS for maintaining a competitive edge in the construction sector. Moreover, similar correlations between education, job satisfaction, and performance have been observed in other sectors, including education (Mase, 2020), manufacturing (Sony & Mekoth, 2016), finance (Bakoti, 2016), and small and medium enterprises (Pagan, 2011), highlighting the universal importance of these factors across industries

Empirical literature indicates that job satisfaction (JS) significantly influences project management performance (PMP) (Masood et al., 2020), as JS plays a crucial role in human resource management by shaping the attitudes and behaviors of construction site workers (Şimşek & Gürler, 2019; Usukhbayar & Choi, 2020). Similarly, studies have shown that project management training (PMT) positively impacts PMP (Çelik & Oral, 2021). In particular, the acquisition of diverse project management skills by project managers and team members has been found to enhance PMP significantly (Zhao et al., 2020). Furthermore, strong associations between education, job satisfaction, and performance have been established in several sectors, including education (Vila & García-Mora, 2005), manufacturing (Sony & Mekoth, 2016), finance (Bakoti, 2016), and small and medium enterprises (Pagan, 2011). Most of the reviewed studies were conducted outside Nigeria, and their findings may not be fully applicable to the Nigerian context due to significant differences in political, economic, and environmental conditions (Pinnington & Mir, 2014; Pancasila et al., 2020; Ni et al., 2022; Zhao et al., 2020; Zhang et al., 2024; Yahaya, 2021). Furthermore, a number of existing studies including those by Anderson

and Lannon (2019), Okechukwu (2017), Huang (2019), Hwang et al. (2019), and Muntazeri and Indrayanto (2018) did not conceptualize or empirically examine the mediating role of Project Management Training, which is a key focus of the present study. In addition, while previous research on Job Satisfaction (JS) and Project Management Performance (PMP) has largely drawn upon theories such as Expectancy Theory (Oktavia, 2020), Theory of Planned Behavior (Ni et al., 2022), Transformational Leadership Theory (Fareed et al., 2022), and Human Capital Theory (Mustafa et al., 2021), this study introduces the Path-Goal Theory as an additional theoretical lens. Unlike prior studies that primarily relied on basic statistical techniques such as Ordinary Least Squares (OLS) (Bitamba & An, 2020), this study employs a more sophisticated analytical approach Path Analysis using Structural Equation Modelling (PA-SEM) to yield deeper and more robust insights. PA-SEM, is particularly suited for testing complex theoretical models that include multiple interrelated dependent and independent variables and latent constructs measured by several indicators. Path analysis, as a special case of SEM, allows simultaneous estimation of direct, indirect, and total effects, enabling researchers to uncover mediating mechanisms that conventional regression cannot fully capture (Kline, 2023; Hair et al., 2022).

Considering the documented links between project management training (PMT) and project management performance (PMP), as well as between job satisfaction (JS) and PMP, it is reasonable to propose that PMT could act as a mediator in this relationship. To address this gap, this study aims to explore the potential mediating effect of PMT on the relationship between job satisfaction and project management performance. Accordingly, the research is guided by the following questions: How does job satisfaction influence project management performance within Nigeria's construction industry? What effect does project management training have on project management performance? And does project management training mediate the relationship between job satisfaction and project management performance?

2. Literature Review

2.1. Theoretical Framework

The theoretical framework underpinning this study is the Path-Goal Theory, originally developed by Martin Evans in 1970. This theory explains how project supervisors can effectively motivate construction workers to achieve established goals by aligning leadership behaviours with workers' needs and the demands of the task. In the context of the construction industry, the theory emphasizes a supervisor's ability to recognize employee needs, deploy a range of skills, tools, and methodologies, and inspire subordinates to meet project objectives delivering outcomes on time and within budget. Path-Goal Theory positions project management training (PMT) as a key motivational instrument that significantly influences project management performance (PMP) (Hutajulu, 2020). This perspective aligns with Pinnington and Mir's (2014) findings that the availability of relevant project management techniques, skills, and tools to construction workers directly enhances their performance and supports successful project delivery. The theory also posits that construction workers experience greater job satisfaction when supervisors engage them through regular consultation, adopt up-to-date practices, invite feedback, involve them in decision-making, ensure their well-being, maintain equitable treatment, and express confidence in their abilities (Khahro et al., 2024).

Supporting this view, Masood et al. (2020) found that construction workers are more committed to project success when supervisors provide clear and unobstructed communication of project goals. Similarly, Zhang et al. (2024) echo the theory's assertion that project supervisors can influence workers' long-term engagement and reduce turnover by equipping them with key project management techniques and fostering self-confidence. In the same vein, Hailu, and Tshehla (2024) affirm that effective guidance from project supervisors enables construction workers to complete complex tasks beyond their initial capacity. Path–Goal Theory emphasizes that leaders enhance subordinate performance by clarifying goals, removing obstacles, and matching leadership style to employee needs (Northouse, 2022). Construction supervisors routinely confront heterogeneous teams and dynamic site conditions, conditions in which adaptive leadership behaviours—directive, supportive, participative, and achievement-oriented—are critical for sustaining productivity and safety.

2.2. Job Satisfaction

Job satisfaction is the positive feeling employees have when their job meets their needs for fair pay, good conditions, respect, and growth, leading to motivation and productivity, while low satisfaction causes stress, poor performance, and higher turnover (Çelik & Oral, 2021). Job satisfaction in the construction industry is the degree of contentment and well-being that workers, ranging from labourers to project managers, feel about their jobs. It reflects how secure, valued, and fulfilled they are, shaped by factors such as site safety, fair wages, supportive supervision, growth opportunities, and the physical work environment (Zhao et al., 2020; Mustafa et al., 2021). Because construction involves demanding conditions, frequent site changes, and physical risks, satisfaction depends heavily on safety measures, proper equipment, and fair compensation, including benefits and overtime pay (Karaman, 2022). Effective leadership, clear communication, and career development opportunities further strengthen morale (Magazi & Kikwasi, 2022). High job satisfaction promotes productivity, quality work, strong safety

behavior, and employee loyalty, while dissatisfaction, often caused by long hours, harsh conditions, low pay, or poor team relations, leads to absenteeism, accidents, turnover, and conflict (Johari & Jha, 2020).

2.3. Project Training

Project Management Training (PMT) grew out of the broader field of project management, which became formalized in the mid-20th century to meet the demands of increasingly complex industrial, military, and construction projects (Kuria & Kimutai, 2020). PMT is a structured approach to developing the knowledge, tools, and skills needed to plan, execute, and control projects effectively (Akhund et al., 2019; Cremers & Houwerzijl, 2021). It covers core areas such as scheduling, budgeting, risk management, team leadership, and the use of project management software (Daoor et al., 2020). Training programs draw on standardized frameworks—like those of the Project Management Institute (PMI)—to help participants deliver projects on time, within budget, and to required quality standards (Sharma et al., 2018; Ivic & Ceric, 2023).

In the construction sector, PMT reflects this multidimensional evolution through flexible formats such as in-person workshops, online courses, on-the-job training, and professional certification programs (Daoor et al., 2020). As Bitamba and An (2020) note, PMT improves project success by strengthening planning, budgeting, and risk control, ensuring efficient use of resources, and fostering clear communication and leadership. It promotes consistent, standardized practices, supports professional growth through certifications, and equips practitioners to manage complex projects while reducing errors and enhancing overall quality (Zhao et al., 2020).

2.4. Project Management Performance

The concept of Project Management Performance (PMP) in the construction industry originates from the broader development of project management as a formal discipline that emerged in the mid-20th century (Johari & Jha, 2020). PMP measures how effectively a project meets its objectives for scope, time, cost, and quality by assessing the efficiency of planning, execution, and control (Hailu & Tshehla, 2024). High performance indicates that a project finishes on schedule, within budget, and to required standards while satisfying stakeholders. Yahaya (2021) adds that PMP captures the extent to which objectives, including scope, time, cost, quality, safety, and stakeholder expectations, are achieved. Unlike outcome-focused evaluations, it emphasizes both the project's process and the manager's competence in navigating constraints from initiation to closure (Usukhbayar & Choi, 2020). PMP also covers communication and stakeholder management, including conflict resolution, collaboration, and satisfaction tracking, all vital for successful delivery in construction settings (Khahro et al., 2024; Karaman, 2022). Strong project management performance brings clear benefits: timely and cost-effective completion (Pancasila et al., 2020), efficient resource utilization (Kuria & Kimutai, 2020), effective risk control (Mahalingam & Nagarajan, 2018), higher team productivity, and a stronger organizational reputation that supports future opportunities (Ma & Fu, 2020).

2.5. Job Satisfaction and Project Management Performance

A substantial body of research in construction studies adopts the definition of job satisfaction (JS) as proposed by Locke (1976), who describes it as a psychological state reflecting an individual's perception and emotional response to their work. This definition has been widely accepted in the field (Johari & Jha, 2020; Vo et al., 2020; Bhardwaj et al., 2021). JS is often conceptualized as the degree of contentment employees feel about their jobs (Usukhbayar & Choi, 2020), or, as Robbins (2005 articulates, the extent to which individuals express a positive or negative attitude toward their occupations. Research indicates that JS is not an isolated phenomenon; rather, it is shaped by a range of organizational factors, including leadership quality, career development opportunities, and overall working conditions, all of which contribute to the organizational climate (Zhao et al., 2020; Magazi, & Kikwasi, 2022). JS has been found to significantly influence various aspects of construction workers' behaviour, such as motivation, commitment, and performance (Usukhbayar & Choi, 2020). Moreover, JS is strongly associated with employee retention and overall life satisfaction, reinforcing its relevance to successful project execution (Çelik & Oral, 2021; Karaman, 2022).

In construction settings, JS has been linked to several important work outcomes, including project manager productivity, workforce stability, and project management performance. For example, Mustafa et al. (2021) found that JS provides a foundation for achieving project management performance (PMP) by supporting goal attainment, cost control, and adherence to timelines. Similarly, Ni et al. (2022) identified JS as a significant predictor of PMP within China's construction industry, while Bhardwaj et al. (2021) confirmed that timely project delivery is closely tied to employee job satisfaction.

Further research supports these findings. For example, Ma and Fu (2020) identified a strong link between job satisfaction (JS) and project management performance (PMP), while Gębczyńska (2020) highlighted that positive employee attitudes significantly improve project outcomes. Similarly, Osama et al. (2023) emphasized the critical role of JS in influencing construction workers' engagement and effectiveness. Aligning with this, Shi et al. (2023) found that JS directly contributes to the timely and cost-effective

execution of construction projects.

2.6. The Mediating Effect of Project Training

Training is a critical component of human resource management, designed to enhance employee capabilities, ultimately leading to improved productivity and performance (Kuria & Kimutai, 2020). Within the construction industry, project management training (PMT) is recognized as a strong predictor of PMP (Sharma et al., 2018; Daoor et al. 2020). Bitamba and An (2020) emphasize that PMT has a direct link with PMP. In a similar vein, Akhund et al. (2019) assert that improving design management within the construction industry (CI) requires the integration of modern technologies that meet the evolving demands of project managers, particularly during the design phase. Project managers are increasingly supported in implementing innovative tools and practices that institutionalize new work methods within organizational processes (Ma & Fu, 2020; Zhao et al., 2020; Cremers, & Houwerzijl, 2021; Ivic, & Ceric, 2023). Consequently, research indicates that training encompasses a set of strategies aimed at increasing job satisfaction (JS) and improving the performance management of construction workers on-site (Magazi, & Kikwasi, 2022; Bamfo-Agyei, Thwala, & Aigbavboa, 2022). Bejide and Iyagba (2015) further note that training not only enhances JS but also boosts construction worker productivity. PMT fosters a positive workplace attitude by equipping workers with the competencies needed to perform effectively while minimizing exposure to occupational hazards, injuries, or fatalities.

Over the past decade, both JS and PMT have emerged as widely studied and positively correlated factors influencing project success. For example, Bamfo-Agyei, Thwala, and Aigbavboa (2022) found that PMT significantly predicts both JS and project management performance (PMP) in Ghana's CI. Similarly, research conducted in Thailand by Matthew et al. (2021) highlight PMT as a powerful human resource tool that enhances both JS and PMP.

Project Management Training (PMT) is expected to mediate the link between Job Satisfaction (JS) and Project Management Performance (PMP) because satisfied employees are more willing to learn and apply new skills (Emmanuel et al., 2020). PMT equips them with essential competencies—such as planning, budgeting, risk control, and quality management—so their motivation translates into measurable project results (Zhao et al., 2020). Grounded in Path–Goal Theory, PMT acts as an "obstacle-removal" mechanism: supervisors clarify goals and provide training that converts positive attitudes into effective task execution (Hutajulu, 2020). Job satisfaction supplies the motivation, while PMT channels that motivation into higher efficiency, stronger coordination, and better project outcomes (Kuria & Kimutai, 2020). Evidence from other sectors shows that training often explains how positive job attitudes become performance gains (Bitamba & An, 2020). In short, job satisfaction creates readiness, but PMT provides the practical tools that transform that readiness into superior project performance, making it a logical mediator between JS and PMP (See Figure 1).

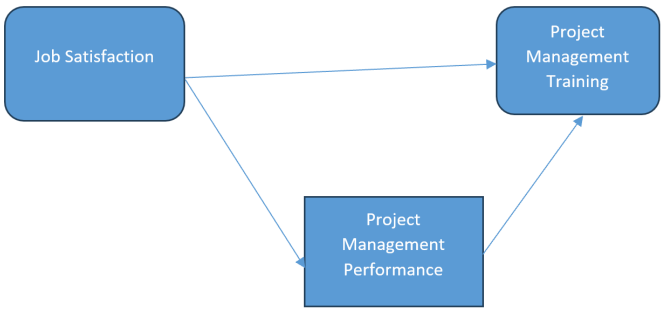

Figure 1: Conceptual Framework for the Study

2.7. Hypotheses of the Research

Drawing from the examination of existing literature, we formulate four hypotheses:

H1: JS is significantly associated with PMP.
H2: JS is significantly associated with PMT.
H3: PMT is significantly associated with PMP.
H4: PMT mediates the relationship between JS and PMP.

3. Methodology

3.1. Participants

A non-probabilistic purposive sampling technique was employed to select 250 respondents from Julius Berger and Reynolds Construction Company. Julius Berger Nigeria Plc and Reynolds Construction Company (RCC) were selected not only for their historical presence in Nigeria before independence, but also for their transparency, as two of the few construction firms

listed on the Nigerian Stock Exchange. Both rank among the nation's top contractors in project scale, workforce, and capital, with a record of delivering major infrastructure such as highways, bridges, and airports. Their mature management structures, formal training programs, and robust human-resource policies provide strong conditions for examining how Project Management Training (PMT) mediates the link between Job Satisfaction (JS) and Project Management Performance (PMP). These qualities make them highly representative and data-rich cases for the study. A total of 208 completed structured, self-administered questionnaires consisting of closed-ended questions based on a 5-point Likert scale ranging from Strongly Disagree (SD) to Strongly Agree (SA) were collected and returned to the researchers over a three-month data collection period, from January 9 to April 10, 2023. Among these respondents, 70% identified as male, while 30% identified as female. The average age of the sampled individuals was 45 years. Regarding educational qualifications, 10% held master's degrees, 60% possessed bachelor's degrees or higher national qualifications, and 40% held professional certificates (practicing licence with council). In terms of work experience, 35% of participants had 5-10 years of experience, 45% had 11-20 years, and 20% had over 20 years of experience.

3.2. Measurements

A quantitative study was carried out using a structured questionnaire to test the hypothesis. Job satisfaction (JS), project management training (PMT), and project management performance (PMP) were assessed with validated scales from Ching-Gu et al. (2014), Diethelm et al. (2016), and Zhao et al. (2020). JS was examined through employee surveys covering safety, fair pay, work–life balance, promotion opportunities, and supervisor–coworker relations. PMT was evaluated by participants' reactions, knowledge gains from pre- and post-tests, on-site application of new skills, and outcomes such as fewer safety incidents or less rework. PMP was measured by project timeliness, budget adherence, quality standards, safety records, and stakeholder satisfaction.

The scale items are presented in a phrase format and are anchored to a 5-point Likert scale. To ensure the measurement model was psychometrically sound for Structural Equation Modeling (SEM), internal consistency and construct validity tests were conducted. Eigenvalues of Principal Components and the Percentage of Variance explained establish that the items cluster meaningfully and capture sufficient variance, supporting factor retention. The Kaiser–Meyer–Olkin (KMO) measure assesses sampling adequacy and verifies that correlations among variables are strong enough for factor analysis, a prerequisite for SEM. Finally, the Cronbach's alpha coefficient evaluates the internal consistency of each construct, confirming that the observed indicators reliably measure the intended latent variables. Collectively, these tests demonstrate that the data meet the reliability and validity requirements for robust SEM analysis (Hair et al., 2022) (See Table 1 in Appendix 1).

From Table 1, The reliability and validity analysis confirm that the research instrument is both statistically sound and theoretically robust. All three constructs—Job Satisfaction (α = 0.872)**,** Project Management Training (α = 0.869)**,** and Project Performance Management (α = 0.867), demonstrate high internal consistency. KMO values above 0.80 indicate sampling adequacy, and eigenvalues above 1 with over 79% variance explained confirm the unidimensionality of each scale. These results validate the questionnaire as a reliable tool for measuring the targeted constructs and support its use in further statistical analyses such as regression or SEM.

3.3. Data Analysis

The collected data were analyzed using Path Analysis within a Structural Equation Modelling (PA-SEM) framework to evaluate the hypothesized relationships among the study variables. The specified model paths were tested, and the findings were reported according to the statistical significance and magnitude of the observed relationships. The data were first screened for missing values, normality, and measurement reliability and validity using factor analysis and internal consistency tests. After confirming data quality, Path Analysis within a Structural Equation Modeling (SEM) framework was conducted to test the hypothesized relationships (Hair et al., 2022). Model fit was evaluated with standard SEM indices, and the path coefficients were estimated to assess the strength and statistical significance of each relationship.

3.4. Ethical Considerations

The study followed key research ethics to protect participants and maintain integrity. Respondents gave informed consent and participated voluntarily. Their identities remained anonymous, with all data securely stored and password protected. The survey posed minimal risk, avoided sensitive content, and allowed withdrawal at any time. Findings were reported honestly, with proper citation to prevent plagiarism. Finally, the research received prior approval from the appropriate institutional ethics committee, ensuring compliance with national and international ethical standards.

4. Results and Discussion

From Table 2, the results of the structural equations model of JS and PMT show that the coefficient of PMT is 0.8334. This indicates that the relationship between JS and PMT is:

PMT = 0.8334 js ……(i)

Table 2: Structural Equation Model of JS and PMP (Direct effects)

Path	B	Std. Err.	z-value	P-value	[95% Conf. Interval]	
PMP <- PMT	.3547205	.0654767	5.42	0.000**	.2263885	.4830525
PMP <- JBS	.2506959	.0857081	2.92	0.003**	.0827111	.4186807
PMT <- JBS	.8334266	.0701567	11.88	0.000**	.6959221	.9709311

Note. ** $p <$ .05, β = coefficient value, Z = computed z-value

Equation (i) indicates that PMT accounts for 83.34% of the variation in PMP. The computed z statistic is 11.88 with an associated p-value ($p < 0.001$). Thus, the positive relationship between PMT and PMP is statistically significant. The implication is that PMT is a significant predictor of PMP. This study supports earlier findings that highlight project management training (PMT) as a key driver of project management performance (PMP). Kuria and Kimutai (2020) identify PMT as a strong predictor of PMP, while Sharma et al. (2018) report a significant positive association between the two. Likewise, Ma and Fu (2020) confirm that PMT is a major determinant of PMP. Zhao et al. (2020) add that PMT enhances skills in scheduling, budgeting, risk management, procurement, and quality control, critical areas for minimizing errors and delays. Ekung and Adewuyi (2018) emphasize that PMT enables managers to allocate labor, equipment, and materials more efficiently, thereby reducing waste and controlling costs. Similarly, Bamfo-Agyei et al. (2022) find that PMT improves accuracy and responsiveness to changing site conditions.

The results of the structural equations model (*direct effects*) of JS and PMP with PMT as the mediating variable indicate that the coefficients of PMT and JS are 0.3547 and 0.2507 respectively. This indicates that the model of JS and PMP with PMT as the mediating variable is:

.PMP = 0.3547 pmt + 0.2507 js

. . . (ii)

Equation (ii) indicates that PMT and JS explain 35.47% and 25.07% of the variation in PMP respectively.

The calculated z values and the associated significant probabilities for PMT and JS are 5.42 ($p < 0.001$) and 2.92 (0.003) respectively. The findings indicate that both project management training (PMT) and job satisfaction (JS) have positive, statistically significant effects on project management performance (PMP). This aligns with Bamfo-Agyei et al. (2022) and Zhang and Fang (2019), who reported that PMT and JS enhance accuracy, adaptability to changing site conditions, motivation, and commitment, thereby improving PMP. Similarly, Adeleke et al. (2020) showed that PMT and JS exert both joint and independent influences on PMP. Collectively, these studies confirm that strong project management training and high job satisfaction are key drivers of superior project management performance in the construction industry.

Table 3 presents the findings on the mediating role of Project Management Techniques (PMT) in the relationship between Job Satisfaction (JS) and Project Management Performance (PMP). The direct model results indicate a significant and positive relationship between JS and PMP (β = 0.250; p = 0.003). PMT also demonstrates a strong association with PMP (β = 0.354; p = 0.000), indicating that both JS and PMT are significant predictors of PMP. Notably, the inclusion of PMT in the model enhances the effect of JS on PMP, as evidenced by an increase in the beta coefficient from 0.250 to 0.295 and a rise in the Z-value from 2.92 to 4.93. This provides empirical support for PMT's role as a mediating variable. The bootstrapping analysis (0.354 * 0.833 = 0.29488) further confirms the mediating effect of PMT. According to Baron and Kenny's (1986)

Table 3: Mediating Effect of PMT on JS and PMP

Path	Estimate	Std. Err.	z-value	P-value	Hypothesis	Remark
Direct Model						
PMP <- JS	.2506959	.0857081	2.92	0.003**	H_1	Confirmed
PMT <- JS	.8334266	.0701567	11.88	0.000**	H_2	Confirmed
PMP <- PMT	.3547205	.0654767	5.42	0.000**	H_3	Confirmed
Indirect Model						
PMP <- PMT<- JBS	.2956335	.0599767	4.93	0.000**	H_4	Partially Confirmed

Note. ** $p <$ .05

mediation framework, partial mediation is established when both the independent variable (JS) and the mediator (PMT) significantly predict the dependent variable (PMP). The findings suggest that PMT partially mediates the relationship between JS and PMP.

The practical implication is that when construction workers are equipped with a broad range of project management skills and tools, especially those suited for managing fast-paced and complex projects, their attitude toward project performance improves. PMT enhances professionals' capabilities by providing up-to-date tools, techniques, and knowledge, which in turn increases job satisfaction. This elevated job satisfaction leads to improved project performance, contributing to organizational success. Consequently, training construction workers in advanced project management techniques and simultaneously fostering job satisfaction can significantly enhance the industry's ability to meet the Sustainable Development Goals (SDGs) by 2030. These efforts will support the revitalization and development of inclusive cities and communities, promoting equitable opportunities for all. This study is consistent with the findings of Bamfo-Agyei et al. (2022), who reported that Project Management Techniques (PMT) significantly predict both Job Satisfaction (JS) and Project Management Performance (PMP). Likewise, a study by Matthew et al. (2021) in Thailand identified PMT as an effective human resource tool that enhances both JS and PMP.

Two goodness-of-fit tests were employed: the equation-level goodness-of-fit test and the Wald test for equations. The model-fit approach evaluates how well the overall model represents the data, while the equation-level test examines the extent to which each individual equation explains its dependent variable. The Wald test further assesses whether the coefficients in an equation or system jointly satisfy theoretical restrictions, thereby confirming the significance and validity of the estimated relationships. From Table 4, the equation-level goodness of fit test shows that the fitted and predicted variance in PMT is 0.48781 and 0.16922, resulting in a computed R-square value of 0.3564. This value indicates that thirty-four point-thirty-six per cent (35.64%) of the variation in the dependent variable in this particular model (PMT) is accounted for by variations in the explanatory variables (PJ and PMP). The correlation between the observed and predicted values is moderate, and the Bentler–Raykov reliability measure confirms these figures. Overall, the model provides a fair but not strong fit, indicating that other factors outside the model still account for a substantial share of the outcomes.

Table 4: Equation-level goodness of fit

Depvars	Variance		Residual	R-squared	Mc	mc2
	fitted	predicted				
Observed						
PMT	.4878219	.1692228	.332008	.356444	.59991	.352133
PMP	.5690409	.1693097	.380211	.318621	.56093	.319538
Overall	**.350086**					

mc = correlation between depvar and its prediction

mc2 = mc^2 is the Bentler-Raykov squared multiple correlation coefficient

The results of Wald's test (Table 5) show that the computed Chi-square and associated significant probabilities are 143.88 ($p < 0.01$) and 148.12 ($p < 0.01$) for PMT and PMP. The null hypothesis for Wald's test is that the coefficients, other than the intercepts, are 0. Thus, the Wald test results show that the predictors in each equation jointly have a strong and significant effect. For both project management training and project management performance, the very low p-values (less than 0.001) mean the variables included in the model explain the outcomes much better than a model with no predictors.

Table 5: Wald tests for equations

	chi2	Df	P
Observed			
PMT	143.88	2	0.0000
PMP	148.12	1	0.0000

4.1. Discussion of Findings

The findings from the structural equation modeling (SEM) provide strong empirical evidence supporting the relationships among Job Satisfaction (JS), Project Management Techniques (PMT), and Project Management Performance (PMP).

4.1.1. Relationship between JS and PMT

From Table 2, the coefficient of 0.8334 indicates a strong and positive relationship between JS and PMT.

This suggests that improvements in job satisfaction significantly enhance the application and use of project management techniques among construction professionals. The high z-value (11.88) and the highly significant p-value ($p < 0.001$) confirm the robustness of this relationship. This suggests that job satisfaction is a key catalyst for the uptake of project management training (PMT). It supports Zhang and Fang (2019), who found that higher job satisfaction among project managers fosters stronger team cohesion and improved project outcomes. Likewise, Adeleke et al. (2020) reported a positive correlation between job satisfaction and construction project performance, driven by greater motivation and commitment. Kuria and Kimutai (2020) further identified job satisfaction as a major determinant of project management performance (PMP), while Sharma et al. (2018) confirmed a significant association between job satisfaction and PMP.

4.1.2. Direct Effects on PMP

Equation (ii) reveals that both PMT and JS have positive and statistically significant effects on PMP, with coefficients of 0.3547 and 0.2507, respectively. The corresponding z-values (5.42 and 2.92) and p-values (< 0.001 and 0.003) reinforce the strength and significance of these relationships. These results highlight that both technical competence (via PMT) and employee well-being (via JS) are crucial in driving project performance. This study aligns with Bamfo-Agyei et al. (2022), who found that project management training (PMT) is a significant predictor of both job satisfaction (JS) and project management performance (PMP). Similarly, Matthew et al. (2021) reported from a Thai context that PMT serves as an effective human resource strategy for improving both JS and PMP.

4.1.3. Mediating Role of PMT

Table 3 confirms the mediating role of PMT in the JS–PMP relationship. The inclusion of PMT in the model not only strengthens the predictive power of JS on PMP (as seen in the beta increase from 0.250 to 0.295 and Z-value from 2.92 to 4.93) but also aligns with Baron and Kenny's (1986) mediation framework. The bootstrapping analysis (0.354 * 0.833 = 0.29488) supports partial mediation, meaning that while JS directly affects PMP, part of its impact is transmitted through PMT. This study reinforces prior research by Bamfo-Agyei et al. (2022) and Matthew et al. (2021), both of which found PMT to be a vital determinant of JS and PMP. These consistent findings highlight the strategic value of PMT as both a technical and human resource development tool.

This finding suggests that human resource managers should view project management training (PMT) as a key strategic tool. Expanding and strengthening training programs magnifies the positive effect of job satisfaction on project performance, enabling motivated employees to deliver higher results. Incorporating PMT into talent-development plans and monitoring its outcomes can build both workforce capability and organizational success. Moreover, improving project results requires more than boosting morale. Well-targeted PMT closes critical skill gaps, prepares employees for complex project demands, and enhances engagement, an urgent priority amid labour shortages and limited experienced personnel. The study therefore urges managers and policymakers to combine robust training initiatives with efforts to increase job satisfaction, ensuring a skilled and motivated workforce that can sustain strong performance in the construction sector.

5. Conclusion

This study examined how project management training (PMT) shapes the link between job satisfaction (JS) and project management performance (PMP) in Nigeria's construction sector. Using structural equation modeling with data from 208 industry professionals, it tested both direct and mediating effects. Results show that JS significantly boosts PMP, confirming earlier research. PMT also exerts a strong positive impact on PMP and partially mediates the JS–PMP relationship, indicating that training strengthens—but does not replace—the influence of job satisfaction on performance. The findings highlight that enhancing project outcomes requires more than improving employee morale. Targeted PMT equips workers to manage complex project demands, raises engagement, and improves overall performance. By providing evidence from an underexplored context, the study advances behavioral science literature and guides managers and policymakers: combining robust project management training with strategies to increase job satisfaction is essential for improving construction project delivery and supporting sustainable development goals.

5.1. Theoretical implications

Theoretical implications of this study are grounded in the Path-Goal Theory, originally proposed by Martin Evans in 1970. This study extends the application of Path-Goal Theory in the context of construction project management by highlighting how project supervisors can effectively motivate construction workers to meet project goals. The study reinforces the theoretical understanding that a supervisor's ability to recognize and address worker needs, utilize a diverse set of skills and tools, and align leadership behaviors with task demands is essential for achieving successful project outcomes. This study contributes to Path-Goal Theory by emphasizing the significant role of Project Management Training (PMT) as a motivational tool, which enhances Project Management Performance (PMP). By integrating PMT into the framework, the study supports the idea that providing construction workers with relevant skills, tools, and methodologies is central to improving performance and achieving

project objectives. The findings suggest that PMT is not only a means of enhancing technical abilities but also a driver of job satisfaction, as it fosters greater engagement, confidence, and competency among workers. Furthermore, the study affirms that the behaviors of project supervisors, such as consistent communication, shared decision-making, and confidence in workers' capabilities, align with the Path-Goal Theory's assertions about leadership's impact on employee satisfaction and performance. The findings strengthen the theory's premise that effective leadership and supportive training environments are critical for promoting positive worker attitudes and performance outcomes.

This study expands on the theoretical literature by illustrating how PMT mediates the relationship between Job Satisfaction (JS) and PMP. The results suggest that PMT not only influences PMP directly but also enhances the influence of JS on PMP, reinforcing the importance of comprehensive, integrated approaches to project management in the construction sector. In summary, the application of Path-Goal Theory in this study provides valuable insights into the link between leadership, training, job satisfaction, and project performance, offering a deeper theoretical understanding of how these elements interact to achieve successful project outcomes.

5.2. Practical Implications

This study presents important practical implications for the construction industry, employees, and policymakers. For the construction industry, the findings identify Project Management Training (PMT) as a critical driver of Project Management Performance (PMP). Given that PMT accounts for a substantial proportion of the variation in PMP, construction firms should prioritize ongoing training and capacity building in modern project management techniques. Such investments not only enhance the technical proficiency of workers but also lead to more efficient project execution, reduced delays, and improved organizational outcomes. Since both PMT and Job Satisfaction (JS) significantly influence PMP, companies are encouraged to adopt a comprehensive human resource strategy that combines technical training with measures to improve workplace conditions and employee morale.

For employees, the study emphasizes the value of continuous learning and professional development. Increased access to training opportunities not only enhances technical skills but also contributes to greater job satisfaction and performance. Employees who are well-trained in current project management tools and methodologies are better equipped to navigate the complexities of modern construction projects, thereby strengthening their career trajectories and boosting their professional confidence. The positive interaction between JS and PMP suggests that satisfied and capable employees are more likely to thrive and receive recognition for their contributions.

For policymakers, the results support the development of policies that promote or require training and certification in project management within the construction sector. Incorporating PMT into national workforce development strategies can play a vital role in achieving long-term economic and infrastructure goals, including the Sustainable Development Goals (SDGs). By encouraging collaboration among government agencies, academic institutions, and industry stakeholders, policymakers can help mainstream project management training and ensure that the construction workforce is equipped to support sustainable, inclusive urban development.

5.3. Limitations and future research

This study is limited by its cross-sectional design, which restricts causal inference, and by data drawn from a single national context and a relatively small sample of construction professionals. Future research could adopt longitudinal or multi-country designs, include other sectors with similar HR challenges, and explore additional variables, such as technological adoption, leadership style, or organizational culture, that may strengthen or weaken the PMT–job satisfaction–performance–performance link. Such work would provide deeper insight into how targeted training and employee satisfaction interact to sustain high performance in diverse environments.

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Appendix 1

Table 1: Results of the Reliability of the Research Instrument Measurement

Variable		**Cronbach's alpha**	**KMO**	Eigenvalue of the principal Component	% of the Variance
JBS Scale-Cronbach Alpha (JBS = 0.872)			**0.827**	**3.025**	**79.59%**
JBSQ 1	Praise for work in the field is encouraging.	**0.832**			
JBSQ 2	I am comfortable and productive working alone on construction sites.	**0.831**			
JBSQ3	I appreciate the respectful and supportive work environment created by the project manager.	**0.789**			
JBSQ 4	My project manager has excellent decision-making authority	**0.814**			
JBSQ 5	Satisfied with the implementation of the organization's policies	**0.822**			
JBSQ6	I am happy with the opportunity to try my method in the field.	**0.838**			
PTR Scale - Cronbach Alpha – (GTR= 0.869)			**0.841**	**3.087**	**81.17%**
PTRQ1	In my organization, we conduct annual managerial project training sessions.	**0.816**			
PTRQ2	We consistently assess the demand for project managerial training and communicate this to our construction workers	**0.823**			
PTRQ3	We are continually seeking to enhance our project management knowledge.	**0.806**			
PTRQ 4	We frequently arrange seminars and workshops on project managerial training for our construction workers.	**0.820**			
PTRQ 5	We consistently evaluate the performance of our managerial training programs.	**0.794**			
PTRQ 6	We regularly offer training courses to raise awareness of project performance among our construction workers.	**0.807**			
PPM Scale- Cronbach Alpha – (PPM = 0.867)			**0.832**	**3.083**	**84.46%**
PPMQ 1	With the full support of our staff, the project is always completed on time	**0.824**			
PPMQ2	The diversity of skills in each worker category leaves room to meet budgetary requirements.	**0.789**			
PPMQ3	Involving employees in task completion helps organizations meet project expectations.	**0.822**			
PPMQ 4	The value of work in terms of company performance has led to increased revenue.	**0.798**			

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Prioritizing Strategies for Surviving Economic Turbulence: Case of Quantity Surveying Consultancy Organizations in Nigeria

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Abstract

Economic contraction is inevitable in any business lifetime and often hinders it from achieving the desired objectives. The need to adopt proven survival strategies is essential to survive the adverse effects of economic downturn in most developing countries. Of the construction-related organizations, quantity surveying consultancy organizations often suffer the highest effect of economic turbulence because they are majorly classified as micro-sized or small-sized firms. In developing countries however, firms in these classifications are the livewire of the construction industry. Hence, the need to assess the strategies for surviving economic turbulence with a view to prioritizing the strategies to be adopted for enhancing the continual service delivery of quantity surveying consultancy organizations. To achieve this study's goal, quantitative research approach was adopted and through the questionnaire-survey, data was obtained from top management or principal partners of 99 quantity surveying consultancy organizations in South-western, Nigeria. The data collected were analysed using descriptive and inferential statistics including mean score, standard deviation, Kruskal Wallis test, Mann Whitney test, reliability test, normality test, and factor analysis. Horn parallel analysis was further conducted to determine the appropriate factors from the principal component analysis generated from the factor analysis. Based on the results of the analysis, the prioritized strategies for surviving economic turmoil include 'organizational development and innovation', 'merger and partnership', and 'business and marketing strategies'. The need for embracing innovation in service delivery of quantity surveying firms, engaging competent management head for appropriate decision-making are recommended.

Keywords: construction organizations, economic turbulence, firm survival, Nigeria, quantity surveying, strategies.

1. Introduction

The construction industry contributes substantially to any economy, accounting for more than 15% of the GDP and about 7% of employment globally (Mazhar & Arain, 2015:434). Likewise, Nigeria's construction industry contributes to the economy through the creation of employment, provision of housing and infrastructural development, to mention but a few. Basically, the economy is influenced by construction services offered by professional consultancy organizations (Boussebaa and Faulconbridge, 2019:80) such as quantity surveying firms that use cost expertise to satisfy clients' financial issues (Olanipekun et al., 2014); real estate consultancy organizations providing specialized services for clients on risks and benefits of property investments (Oyetunji et al., 2018:8); architectural consultancy firms guiding the design process, construction and management practices of project for the client (Oluwatayo & Amole, 2012). These professional service firms are often categorised as small and medium enterprises (SMEs) and they positively impact the economy. Thus, their growth and survival are paramount to the economy through continuous construction and engineering developments (Okereke et al., 2022). However, the variability of the economy from boom to blast and the global crisis occasioned by the Coronavirus pandemic (COVID-19), made these construction organizations and stakeholders more vulnerable to financial and non-financial issues in achieving organization objectives (Olanrewaju et al., 2023:5).

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Among these professional service organizations is the quantity surveying consultancy organization saddled with ensuring financial probity in construction processes for meeting the needs of clients (Antwi-Afari et al., 2018). The survival of quantity surveying firms is often threatened due to the changing and highly competitive business environment (Mohd-Rahim et al., 2013:17). Additionally, the new and young quantity surveying consultancy firms find it difficult to build reputations in the public sector due to their marketing ethics and inexperience which leave them struggling to grow and survive. The response of organizations to the pressure of the market impacts the survival tendency of the firm negatively, leading to either decline or exit during the economic downturn (Smallbone et al., 2012). Besides, majority of quantity surveying organizations perform poorly and struggle to survive stiff competition in the industry (Ogbu, 2015). Furthermore, the poor growth of quantity surveying consultancy organizations is a function of their low participation in engineering projects (Olatunji et al., 2017). Recently, Moyanga et al. (2024) submitted that quite a number of quantity surveying firms are failing as a result of increasing hazard rates from external finances obtained by them during the economic crisis. However, the survival of construction organizations could be attained through the innovation, diversification, partnership, etc; but the stereotyped nature and structure of quantity surveying consultancy firms contributed to the obstacle to adopting innovative practices (Chong et al, 2020; Moyanga et al., 2023:10). Notably, construction organizations require that they set up techniques and make strategic decisions to deal with the challenges facing them as well as survive competition.

In the quest to enhance the survival of construction organizations, studies have investigated the survival practices of contractors (Ogbu, 2018) and strategies to manage the financial crisis due to COVID-19 (Jayalath & Gamage, 2021). Besides, Aghimien et al. (2018) assessed the survival strategies of built environment firms (i.e., building, engineering, architectural, estate management, and quantity surveying) before the outbreak of the global pandemic. Although this study shows insignificant differences in the opinions of five groups of respondents in most of the variables, there is a need to further investigate the survival strategies that can be adopted by the individual professional firms (firm-based opinion), especially quantity surveying firms. This is essential because most firms delivering quantity surveying services are small or micro-sized, and could be more susceptible to economic turbulence than other construction firms. Specifically, some past studies have assessed strategies for quantity surveying firms to survive the economic crisis in Nigeria (Okereke et al., 2022), and Kenya (Gachuma & Karugu, 2018). However, descriptive statistics were mainly used to explore the awareness level and usage of survival strategies in the studies, and data were obtained from a city, which makes the scope of the respondents limited. Hence, there is a need to further investigate the survival strategies of quantity surveying firms in economic turmoil within a larger scope and obtain possible divergent opinions considering some variables such as firm size, year of establishing firm, etc. which have not been established by past studies. The premise that quantity surveying consultancy organizations are slightly growing in size when compared to their year of establishment and the adoption of survival strategies depends on characteristics of firms. It is also essential to group the variables of survival strategies into manageable sizes to enhance the decision-making of quantity surveying firms or other professional-allied firms. This current study is crucial to quantity surveying consultancy organizations in developing countries where economic recession is constantly experienced (Aghimien et al., 2018). In addition, the study also created a path of knowledge and strategic action practices for construction enterprises in Nigeria and other developing countries.

2. Review of Literature

Firm survival is largely attributed to organizational strategies (Supangkat and Widiana, 2022), which is a long-term plan from the evaluation of both internal and external environment to achieve the organization's goal and vision (Alharafsheh & Ezmigna, 2023). Strategy is majorly defined based on perspectives of the circumstances under study. For instance, David (2011) defined strategy as a course of action requiring top management decisions and resources for achieving the organization's long-term goals. Monday and Aladeraji (2015) viewed strategy as the business plans or approaches used by the management of firms to achieve organizational goals. However, the quest to survive any business environment is driven by certain strategies which organization owners uphold for their establishments. Survival strategy is referred to as some distinctive efforts, both psychological and behavioural, that are created by individuals or organizations to endure and minimize stressful or frustrating periods (Stroe et al., 2018). The generic view of survival strategies connotes a highly volatile business environment; therefore, adopting a single strategy could affect the competitiveness of an organization. Additionally, the choice of strategies has an influence on the survival of any organization (Adebisi and Bakare, 2019), success and competitiveness in the business environment. It is argued that the adoption of survival strategy is a function of the firm characteristics such as size, age, finance, structure, industry-type, etc, (Supangkat & Widiana, 2022; Handoyo et al., 2023). Micro and small organizations depend on agility and are not accessible to funds that can be used to make strategic decision in mitigating their challenges. On the other hand however, larger firm are equipped with more financial resources to implement survival strategies.

Therefore, the need to explore organizational survival strategies becomes imperative to make practical recommendations for construction-related firms.

Strategic alliance is one aspect of business planning used to expand a firm's capabilities to acquire competitive advantage and adapt to market conditions (Kinderis & Jucevicius, 2013). A strategic alliance is an arrangement between two or more independent organizations to cooperate in the production and sale of products/services. Strategic alliance is sometimes referred to as "partnership", which means to join organizations for mutual benefits (Lichtarski, 2022). This often enhances the development of new products or services, streamlining market penetration, innovation, sharing research and development experiences and overcoming ambiguity for firm survival (Hernández et al., 2020). On the other hand, a merger is another survival strategy that companies use to increase their capital to enhance business growth and survival (Osundina et al., 2016). It is an external growth strategy in which two or more organizations combine into a bigger entity (Ejoor et al., 2018; Irayanti, 2019). Organizations may also adopt restructuring during a financial crisis. This involves making changes to the financial and management structure due to the demands of the environment (Umar, 2023).

The innovation level of organizations also plays a key role in a chance to survive a turbulent economy. Therefore, firms and enterprises invest in innovation to meet customer expectations or competitiveness. Innovation is regarded as an incredible strategy to sustain a competitive advantage and survive an economic crisis. Therefore, organizations must invest in research and development to identify innovative means of delivering services or improving products (Ugur et al., 2016). Meanwhile, research and development has been affirmed as an important strategy for the survival of firms during recession (Jung & Kwak, 2018). Through research and development, an organization may decide to diversify its areas of expertise. Diversification is a strategic tool for improving performance and survival in a harsh economy (Oladimeji & Udosen, 2019). As a result of diversification, organizations can utilise available resources and spread risks across businesses to enhance survival and gain competitive advantage (Ojiru, 2023). In addition, organizations with multiple assets can strategically allocate the assets of the firm to other investments to yield more return.

In any organization, strategic procurement management practices are essential to keep the business running smoothly. Procurement management is geared towards achieving the strategic goal of the organization through the management of external resources (Alasfar, 2022). The efficient management of operations and resources in procurement can contribute to the survival of an organization (Karanja & Kiarie, 2015). On the other hand, strategic human resource management can address business problems and directly contribute to long-term business objectives. Although micro and small enterprises may have limited funds and recognition to easily attract top talent, effective human resource management can make them succeed and survive like medium or large firms (Sparrow et al., 2017).

In the management of the organization during a financial crisis, managers may decide to adopt a retrenchment strategy. This strategy is the process of reducing the organization's workforce by terminating some employees' appointments to reduce costs. It leads to reduced resources for the day-to-day running of organization activities (Ung et al., 2018). The management of cash for a firm's liquidity is critically important during the economic downturn (Dzingirai & Ndava, 2022). Therefore, organizations must be structured to effectively manage financial resources during an economic boom. Organizational structure does not only provide a framework with which managers and non-managerial employees perform assigned jobs, it is a starting point for successful management of tangible and intangible assets of a firm. Organizational culture which helps to inculcate a set of values in employees is a vital business strategy for the survival of firms (Atuahene & Baiden, 2018).

Service quality is a global judgment for evaluations (Koozehchian et al., 2011). Practitioners are keen on service quality because of the resultant effects on customer satisfaction, organizational reputation, firm's financial status and operational performance. It is an essential strategy for the success and survival of firms in a global competitive environment (Poor et al, 2013). Besides, developing unique marketing strategies for the competitiveness of any business can also be advantageous. Marketing is essential for understanding the needs of customers, attracting new customers, educating them and ensuring continuous business with a firm (Gamage, 2022). This is seen in the way firms compete to position their products and services in a specific sector (Thiel, 2017). In this case, the survival of a firm depends on its ability to discover its competitive position while managing other factors to achieve the overall goals (Basco et al., 2019). The choice of survival strategies adopted in organizations may differ based on the level of experience of top management officers, the sector, the type of market, firm size, age, to mention but a few. However, understanding and adopting survival strategies is essential for all categories of establishments to survive economic turbulence (Bhagatkar et al., 2015).

3. Research Methods

The aim of this study is achieved by adopting a survey research design. Through the survey research, data was collected quantitatively via a questionnaire from

quantity surveying consultancy organizations in Nigeria. Top management executives or principal partners of the organizations were purposively sampled because they are ultimately responsible for developing and deciding on the appropriate strategies for implementation in the establishments (Monday & Aladeraji, 2015). The South-west, Nigeria was also purposively selected as the study area because two-thirds of quantity surveying consultancy organizations in Nigeria, and approximately 130 f organizations are located in this region (NIQS, 2021). The firms in each States in South-west is presented thus; Ekiti (10), Lagos (55), Ondo (15), Ogun (15), Osun (10), and Oyo (25). The questionnaire was used to request for background information of firm such as the year of establishing the firm and the number of employees, as well as the organizations' perspectives on survival strategies. The survival strategies sourced from extant literature were asked on a 5-point Likert scale ranging from 1 representing 'strongly disagree' to 5 which represented 'strongly agree'. 99 questionnaires, representing a 76.2% response rate, were retrieved out of the 130 copies distributed. This number is considered suitable for both descriptive and inferential analyses.

The analyses conducted in this study include mean score, standard deviation, factor analysis, reliability test, normality test, Kruskal-Wallis H-test, post hoc test and Horn parallel analysis. To rank the opinions of the respondents on survival strategies, a mean score was used while the standard deviation was used to determine the appropriate ranking of two variables with the same value as the mean score. Variable having a lesser standard deviation is highly ranked because of its closeness to the mean value (Oladinrin et al., 2023). Shapiro Wilk test was used to check the normality of the responses obtained on the survival strategies (Mishra et al., 2019). Having established the normality of the distribution based on the significance level ($p \leq 0.05$) of the variables, the Kruskal Wallis H test was computed to compare the differences in opinions of firms in various groups (classifications of firm age/years of establishment in this study). Kruskal Wallis test is a non-parametric analysis used for testing independent samples from the same distribution (Ostertagova et al., 2014). Thereafter, a post hoc test was conducted to identify where the differences occurred by conducting a pairwise comparison. In addition, the Mann-Whitney test was computed to identify potential significant differences between the two groups (micro and small sized firms) in the study. The firm size in this study was operationalized based on the number of employees and the classification of firms in Nigeria submitted by Small and Medium Enterprises Development Agency of Nigeria (SMEDAN)(2012) and the National Bureau of Statistics (NBS) (2015) that micro-enterprise employs between one to nine people; small enterprise employs between 10 and 49 employees and while medium employs from 50 to 199 employees. Finally, the survival strategies were categorised into manageable sizes using factor analysis, while the reliability of the factor generated (in terms of internal consistency) was checked using Cronbach Alpha (Hair et al., 2010). Horn's parallel analysis was adopted to identify the factors that are important to be retained for discussion and the firm's managerial decision. Lim and Jahng (2019) opined that parallel analysis is one of the best procedures for ascertaining the number of factors to use. For this current study, the decision for the number of components was centred on the comparison of eigenvalues of the factors from both analyzes.

4. Results

4.1. Background Information of Firms

This study is firm-based and as such only information about quantity surveying firms was collected. The Table 1 revealed that larger numbers of these firms were established about 15 years at the point of investigating them though majority of them have less than 10 employees. This implied that majority of quantity surveying firms in South-western region of Nigeria are micro-sized organizations though owned by partners and established about 15 years ago. This category of organization is susceptible to the negative impact of economic turbulence and is required to put in place strategies to survive.

Table 1: Characteristics of QS Firms

Characteristics	Category	Frequency	Percent
Years of Establishment of Firm	1-5 years	9	9.1
	6-10 years	20	20.2
	11-15 years	18	18.2
	16-20 years	15	15.1
	above 20 years	37	37.4
Number of Employees/Firm Size	1-9 staff	83	83.8
	10-49 staff	16	16.2

4.2. Rating of Survival Strategies

4.2.1. Mean Score

Table 2 displays the overall mean values of 22 survival strategies identified from extant literature, and the mean score according to the organizational size,

Table 2: Adoption of Survival Strategies by Firm Size

Code	Survival Strategies	S-W (Sig)	Overall		Micro-sized firms		Small-sized firms		M-W(Sig)
			M	SD	M	SD	M	SD	
S20	Improving service quality	0.000*	4.32	0.74	4.35	0.76	4.19	0.66	0.301
S18	Cash management	0.000*	4.20	0.86	4.16	0.88	4.44	0.73	0.258
S22	Improving procurement management	0.000*	4.14	0.78	4.13	0.81	4.19	0.66	0.979
S21	Organizational culture development	0.000*	4.09	0.83	4.10	0.86	4.06	0.68	0.777
S3	Diversification	0.000*	4.06	1.02	4.04	1.02	4.19	1.05	0.489
S6	staff development	0.000*	3.98	1.02	3.96	1.03	4.06	1.00	0.753
S4	Product and service branding	0.000*	3.96	1.09	3.94	1.07	4.06	1.18	0.528
S17	Contacting past clients	0.000*	3.94	0.97	3.96	0.97	3.81	0.98	0.510
S12	Innovation or technological upgrade	0.000*	3.92	0.85	3.98	0.81	3.63	1.02	0.178
S1	Strategic alliance	0.000*	3.89	0.86	3.86	0.81	4.06	1.06	0.226
S10	Marketing strategies	0.000*	3.88	0.92	3.86	0.94	4.00	0.82	0.687
S15	Improve organization structure	0.000*	3.80	0.99	3.69	1.02	4.38	0.50	**0.011***
S13	Prioritizing research and development	0.000*	3.77	1.03	3.77	1.04	3.75	1.00	0.906
S9	Restructuring	0.000*	3.72	0.97	3.66	1.00	4.00	0.73	0.252
S5	Asset allocation	0.000*	3.64	0.93	3.59	0.87	3.88	1.20	0.242
S16	Globalizing human resource management	0.000*	3.63	0.97	3.60	0.99	3.75	0.86	0.662
S19	Cost or Service charge reduction	0.000*	3.63	0.97	3.51	0.94	4.25	0.86	**0.004***
S7	Financial Partnership	0.000*	3.55	1.11	3.59	1.12	3.31	1.08	0.370
S8	Leverage partnership	0.000*	3.43	1.02	3.47	0.95	3.25	1.34	0.641
S14	Contract-based employment	0.000*	3.41	1.08	3.33	1.11	3.88	0.81	0.064
S2	Merger	0.000*	3.27	1.15	3.35	1.09	2.88	1.41	0.143
S11	Retrenchment	0.000*	3.06	1.15	3.10	1.13	2.88	1.26	0.563

Note: S-W = Shapiro-Wilk, M = Mean, SD = Standard deviation, M-W = Mann-Whitney

namely micro and small firms. The result of the overall mean values shows that "Improving service quality (S20) ranked highest with a score of 4.32, followed closely by "cash management (S18) with a mean value of 4.20. "Improving procurement management (S22)" and "organizational culture development (S21)" ranked in the third and fourth positions with values of 4.14 and 4.09 respectively. The survival strategy with the least mean value is "retrenchment (S11)". It is noteworthy that the standard deviations of 13 survival strategies are less than 1.00, while others are approximately 1.00 (see Table 2). This depicts the variability of the dataset in the opinions of the respondents on the variables are very minimal.

Testing the normality of the data, the result from the Shapiro-Wilk in Table 2 shows that the distribution of the variables significantly deviated from normality with significant values less than 0.05 ($p < 0.05$). This implies that the variables on survival strategies based on firms' responses are not distributed normally and as such non-parametric test such as Mann Whitney U and Kruskal Wallis were conducted to compare the resultant mean of the variables between the respondents in micro and small organizations. Notably, only two survival strategies namely "Improve organization structure (S15)" and "Cost or service charge reduction (S19)" have divergent views in the response of the respondents with significant values of 0.011 and 0.004 respectively.

4.2.2. Kruskal Wallis Test

The mean score values and standard deviations concerning the years of establishment of quantity surveying consultancy firms are revealed in Table 3. The mean values of the survival strategies of firms established 1-5 years range from "retrenchment (S9: M=2.56)" and "improving service quality (S20: M=4.33)", while the values of "retrenchment (S9: M=2.85)" and "staff development (S6: M=4.30)" were the least and highest mean scores according to the respondents in establishments 6-10 years. Notably, the least scored survival strategies in quantity surveying firms established 16-20 years is also "restructuring (S9: M=3.40)", while both "improving service quality (S20)" and "improving procurement management (S22) have the highest mean values of 4.20 in the category of firms established 16-20 years. On the other hand, "improving service quality (S20: M=4.67" and M=4.24)" were recorded as the highest mean values among the survival strategies of quantity surveying organizations founded 11-15 years and above 20 years respectively (see Table 3 in Appendix 1). As presented in Table 3, a significant difference occurred only in "globalizing the human resource management (S16)" with a significant value (p=0.042). This indicates that the views of the different organizations according to their years of establishment are the same on the remaining twenty-one survival strategies.

Table 4: Post-Hoc Analysis

	Test statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.
Globalizing the Human Resource Management (S16)					
6 - 10 years – 16 - 20 years	-14.083	9.386	-1.500	0.134	1.000
6 - 10 years – Above 20 years	-17.645	7.627	-2.314	0.021	0.207
6 - 10 years – 1 --5 years	22.994	11.030	2.085	0.037	0.371
6 - 10 years – 11 - 15 years	-26.002	8.928	-2.915	0.004	**0.036***
16 - 20 years – Above 20 years	-3.561	8.411	-0.423	0.672	1.000
16 – 20 years – 1 – 5 years	8.911	11.587	0.769	0.442	1.000
16 - 20 years – 11 - 15 years	11.939	9.607	1.243	0.214	1.000
Above 20 years – 1 - 5 years	5.350	10.213	0.524	0.600	1.000
Above 20 years – 11 - 15 years	8.378	7.897	1.061	0.289	1.000
1 - 5 years – 11 -15 years	-3.028	11.219	-0.270	0.787	1.000

4.2.3. Post Hoc Test

From the post hoc test, Table 4 showed the results using Bonferroni adjustment for Type 1 errors on the survival strategies of quantity surveying consultancy organizations where there are significant differences from the Kruskal–Wallis H test. This significant difference presented in Table 4 revealed that "globalizing the human resource management (S16)" occurred in quantity surveying organizations that were established between 6-10 years and 11-15 years with a significant value (p- 0.036). The difference in the opinions of the two groups could be linked to the capital asset of the firms, international affiliation, and the prowess in the use of digital technology for human resource management activities. Quantity surveying firms with over 10 years of experience may have formed ties with other foreign professionals that were met during international conferences and symposiums. Maintaining relationships with other foreign organization owners could help to source a workforce with global capabilities and also secure foreign jobs.

4.3. Prioritizing Survival Strategies

4.3.1. Factor Analysis

To conduct the factor analysis, the factorability of the 22 survival strategies was first determined. From the results presented in Table 5, the value of Kaiser-Meyer-Olkin (KMO) is 0.770 and Bartlett's test of specificity is p=0.000. The KMO is higher than the recommended minimum value of 0.600 (Shrestha, 2021), and the significant value from Bartlett's test depicts that the collected data on survival strategies are adequate and

Table 5: Reduced Components of Survival Strategies

Factor	Item	Factor loading	Alpha value
KMO 0.770			
Organization and Innovation Development (OID)	S22- Improving procurement management	0.776	0.854
	S4- Product and service branding	0.721	
	S21- Organizational culture development	0.731	
	S15- Improve organization structure	0.688	
	S20- Improving service quality	0.684	
	S12- Innovation or technological upgrade	0.558	
	S13- Prioritizing research and development	0.568	
Merger and Partnership (MP)	S2- Merger	0.859	0.723
	S7- Financial partnership	0.732	
	S11- Retrenchment	0.529	
	S8- Leverage partnership	0.531	
Business and Marketing Strategies (BMS)	S3- Diversification	0.788	0.807
	S10- Marketing strategies	0.831	
	S9- Restructuring	0.664	
Resource Administration (RA)	S1- Strategic alliance	0.810	0.743
	S6- Staff development	0.620	
	S18 Cash management	0.608	
	S5- Asset allocation	0.528	
Organizational Management (OM)	S16- Globalizing human resource management	0.681	0.440
	S17- Contacting past clients	0.649	
Organizational Regulator (OR)	S19- Cost / Service charge reduction	0.795	0.594
	S14- Contract-based employment	0.724	

suitable for factor analysis.

The result in Table 5 shows the principal component analysis and the reliability test of the survival strategies. Out of the 22 survival strategies, 6 principal factors were generated with an eigenvalue greater than 1 and were extracted from the rotated matrix using the Varimax rotation method. To test for the reliability of the variables, the 6 principal survival strategies were subjected to Cronbach's alpha test. Also, the rotated component matrix shows that 5 out of the 6 principal factors of the survival strategies have alpha values ranging from 0.594 to 0.854 while one is below the 0.500 minimum acceptable alpha value (Rodriguez Anez et al., 2008). In past studies, there existed diverse benchmarks for Cronbach's Alpha value. Alpha values between 0.7 to 0.9 are often used as an acceptable threshold by some researchers (Olaniyi, 2019), an alpha value of 0.6 is used in some studies (Hair et al., 2010; Shrestha, 2021), while 0.5 could also be considered reliable (Rodriguez Añez et al., 2008). However, the increase in alpha value depends on the sample size (Bujang et al., 2018), and the low alpha coefficient could be based on the heterogeneity of the variables (Kocak et al., 2014). The low alpha value of "organizational management (OM)" is linked to the small dataset and heterogeneity of the variables (Crocker & Algina, 1986). Since categorising the variables is exploratory and the chances that future studies could obtain a high Cronbach Alpha value, the low alpha value for this study is considered acceptable.

In this study, the naming of the principal factors was based on the researcher's judgement since there is no universal pattern of naming reduced factors in factor analysis (Yong & Pearce, 2013). Hence, the names given the principal factor are adjudged to be satisfactory. The factor names for the survival strategies include organizational and innovation development (OID), merger and partnership (MP), business and marketing strategies (BMS), organizational management (OM), resource administration (RA) and organizational regulator (OR).

Comparing the six (6) factors obtained from the principal component analysis (PCA) with the result of Horn's parallel analysis, Table 6 shows the decision for the numbers of the factors to retain considering the eigenvalues and criterion values. The result depicts that the factors having the lower criterion value from the parallel analysis (PA) compared with the eigenvalues from the PCA were accepted. The result revealed that the three factors to be retained are "organization and innovation", "merger and partnership", and "business and marketing strategies".

4.4. Discussions

The finding of this study from the mean analysis revealed that considering the size (micro and small) and years of establishment of the firm, the survival strategies mostly adopted by quantity surveying consultancy organizations during economic contraction includes improving service quality, cash management, improving contract management, organizational culture development and diversification. Construction organizations, most especially small firms in Nigeria adopts strategies relating to organization and resource management for survival during economic instability (Ogbu, 2018; Adu et al., 2020). In Malaysia, Chong et al. (2020) submitted that quantity surveying consultancy organizations are required to put in place a strategic structure for improved service delivery and profitability to enhance survival.

Based on the size and years of establishment of quantity surveying consultancy organizations, there is no divergent view on the adoption of survival strategies by the different organizations. This supports the assertion that the organizational structure of most quantity surveying consultancy organizations is similar and majority of them are categorised as micro sized organizations (Handoyo et al., 2023; Moyanga et al., 2024). As such, there is consensus in their opinions on the strategies been adopted by them for survival. However, there is divergence in the organizations' view on the adoption of improved organizational structure, service charge reduction and globalizing human resource management as survival strategies.

The study further categorised the survival strategies for service firms so as to enhance better understanding of firm's owner or management personnel on the appropriate strategy to be adopted for survival when the economy contracts. The categorised survival strategies include organizational and innovation development, merger and partnership, business and marketing

Table 6: Comparison of PCA and Horn's Parallel Analysis

Factors	Actual Eigenvalue from PCA	Criterion Value from PA	Decision
Organization and Innovation Development (OID)	6.639	1.964	Accepted
Merger and Partnership (MP)	2.422	1.786	Accepted
Business and Marketing Strategies (BMS)	1.816	1.655	Accepted
Resource Administration (RA)	1.484	1.541	Rejected
Organizational Management (OM)	1.280	1.428	Rejected
Organizational Regulator (OR)	1.185	1.341	Rejected

strategies, resource administration, organizational management and organizational regulator.

4.4.1. Organizational and Innovation Development

The survival strategies under this category of "organizational and innovation development" comprises improving procurement management, branding of products & services, developing the organizational culture, improving organizational structure, improving service quality, innovation or technology upgrade and prioritizing research and development. It is proven by Aghimien et al. (2018) that construction organizations which adopt innovations have a chance of surviving economic turbulence and remaining competitive simultaneously. For quantity surveying organizations, improving on the approaches in procuring services, rebranding services and delivering quality services are easier strategies for implementation at no additional cost. Also, developing and constantly improving the organization's structure and culture is a vital approach for services firms to survive economic contraction (Mashrabjonovich, 2022). All these strategies boil down to devising new or improved ways of service delivery which can be significantly influenced by the size of firms. On the other hand, the type of ownership of the firm must be put into consideration in the decision to adopt organization and innovation development in firms to survive economic turmoil and global financial crisis (Jayalath & Gamage, 2021).

4.4.2. Merger and Partnership

This survival strategy named "merger and partnership" consists of merger, financial partnership, retrenchment and leverage partnership. In times of economic or financial crisis, mergers and different categories of partnerships are important strategies for the continued operations of quantity surveying consultancy organizations in Nigeria's construction market. This is largely due to the size of these organizations and the inability to pay employees because of insufficient financial reserves during economic hard times. Thus, smaller organizations must partner with larger firms, especially for jobs or project opportunities to increase their chances of surviving the contraction of the economy (Irayanti, 2019). In financing and managing projects, a firm's weakness resulting from loan servicing, reduction in employment, low job commissions and death of a firm partner can lead to the extinction of services firms. However, the adoption of a merger or partnership strategy is a panacea for enhancing the firm growth during an economic crisis (Osundina et al., 2016) which in turn helps the firm to stride through to survival. In times of economic turbulence, the area in which a quantity surveying organization is located and the nature of the firm partner/owner influence the decision to merge or partner with other quantity surveying firms for survival.

4.4.3. Business and Marketing Strategies

The business and marketing approaches are vital strategies that quantity surveying organizations can consider and adopt to survive economic contraction. This category of strategy covers diversification, market strategies and restructuring. Diversification is a crucial strategy that service organizations need to adopt to cushion the effect of economic contraction. Therefore, creating and diversifying into other lucrative businesses either in the construction industry or other industries during the economic boom is essential for an unstable economy. On the other hand, intensifying the management of new or secondary business outfits when the primary business is negatively affected by the contraction in the economy is indispensable to enhance survival. In addition, past studies also revealed that adopting new marketing strategies is important to achieve firm goals in terms of growth and survival during economic contraction (Basco et al., 2019; Patel et al., 2021). The marketing strategies can be in the form of improved or alternative ways of procuring and managing the client and projects. However, the location of the firm has a high influence on the decision of the firm's management on whether to adopt diversification, restructuring and strategic marketing to survive.

4.5. Practical Implications

The study revealed the significance of organizational and innovation development as a vital survival strategy. Therefore, it is crucial for quantity surveying consultancy organizations to strategically structure organization employees to manage the services rendered effectively and be innovative. This can be achieved by employing a knowledge manager to undertake research activities to evaluate the existing technologies; services rendered, procurement strategy adopted, etc., and determine ways of improving or upgrading them. On the other hand, quantity surveying firms can collaborate with universities or research institutes to investigate and suggest effective strategies for enhancing innovation for better service delivery. Also, quantity surveying organizations can determine ways of sharing their financial responsibilities with other firms to survive the effects of economic turbulence. Micro-sized firms on the verge of failure can merge with larger firms to sustain their firms through increasing capital base and market share. There is also the need for better 'business and marketing strategies' by quantity surveying consultancy organizations as a strategy to survive the contraction of the economy. Therefore, quantity surveying organizations can employ or engage managerial personnel that are capable of developing and implementing suitable marketing approaches for the firm. This manager should possess the expertise and capability to be able to predict the market, adopt appropriate approaches to acquire jobs and market the services of the organization. In addition, the manager should be able to influence the decision of owners of quantity surveying organizations to explore other

businesses that can be diversified to stay afloat during economic turmoil.

5. Conclusion

This study investigated the survival strategies of quantity surveying consultancy organizations in the Nigerian construction industry since the implementation of survival strategies depends largely on the types and characteristics of the firm. The quantity surveying consultancy organization was used as the focal organization in the industry and the strategies for surviving the effect of economic crisis or contraction were investigated. In contrast to extant studies on survival strategies, this study classified survival strategies for quantity surveying organizations considering possible convergent/divergent opinions based on their internal factors such as size and years of establishment of the firm. The most crucial of the classified survival strategies include organizational and innovation development, merger and partnership, and business and marketing strategies. Based on the results, the study recommends that quantity surveying organizations should undertake research activities for enhancing their firm's innovativeness; partnership with other firms for shared financial responsibilities; micro-sized firms should consider the adoption of mergers for survival.

This study classified and suggested survival strategies for quantity surveying consultancy organizations during the economic crisis in Nigeria, further studies can be conducted for quantity surveying organizations in other countries in Sub-Sahara Africa to determine similarities or differences based on the peculiarities of economies in Sub-Sahara Africa.

Data Availability Statement

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

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Appendix 1

Table 3: Adoption of Survival Strategies by Age of Firm

Survival Strategies	1-5years		6-10years		11-15years		16-20years		Above 20years		Overall		Asymp. Sig.
	M	S.D.	M	S.D.	M	S.D.	M	S.D.	M	S.D.	M	S.D.	
S1: Strategic alliance	3.44	1.13	4.00	0.79	4.06	0.54	4.13	0.92	3.76	0.89	3.89	0.86	0.370
S2: Merger	3.67	0.71	3.40	1.10	3.50	1.15	3.60	1.06	2.86	1.23	3.27	1.15	0.080
S3: Diversification	4.00	0.71	4.15	0.99	4.06	0.94	3.80	1.15	4.14	1.11	4.06	1.02	0.734
S4: Product and services branding	3.44	1.13	4.20	1.01	4.17	0.92	3.87	1.06	3.89	1.20	3.96	1.09	0.407
S5: Asset allocation	3.56	1.13	3.65	0.88	3.44	0.98	3.87	0.83	3.65	0.95	3.64	0.93	0.817
S6: staff development	3.89	1.17	4.30	0.92	4.17	0.86	3.80	1.15	3.81	1.05	3.98	1.02	0.423
S7: Financial partnership	3.56	1.01	3.65	0.93	3.78	1.11	3.87	0.99	3.24	1.23	3.55	1.11	0.507
S8: Leverage partnership	3.22	0.83	3.25	0.79	3.61	0.92	3.67	1.11	3.41	1.19	3.43	1.02	0.506
S9: Restructuring	3.78	0.97	3.65	0.99	3.72	0.75	3.80	1.01	3.70	1.08	3.72	0.97	0.998
S10: Marketing strategies	4.00	0.87	3.80	1.15	4.22	0.65	3.93	0.88	3.70	0.91	3.88	0.92	0.395
S11: Retrenchment	2.56	1.24	2.85	1.18	3.39	0.98	3.40	1.06	3.00	1.20	3.06	1.15	0.232
S12: Innovation or technological upgrade	4.22	0.83	3.90	0.72	4.33	0.69	3.93	0.88	3.65	0.92	3.92	0.85	0.075
S13: Prioritizing research and development	3.67	1.00	3.60	1.19	4.22	0.73	3.67	1.11	3.70	1.02	3.77	1.03	0.406
S14: Contract-based employment	3.22	0.83	3.10	1.29	3.28	1.02	3.60	1.18	3.62	0.98	3.41	1.08	0.398
S15: Improve organization structure	3.78	1.30	3.60	0.94	4.22	0.88	3.47	1.19	3.84	0.87	3.80	0.99	0.241
S16: Globalizing the human resource management	3.89	0.78	3.05	0.94	4.00	0.97	3.60	1.12	3.70	0.85	3.63	0.96	**0.042***
S17: Contacting past clients	4.22	0.44	3.55	1.05	4.00	0.84	4.07	1.03	4.00	1.03	3.94	0.97	0.351
S18: Cash management	3.89	0.93	4.20	0.95	4.39	0.50	4.13	0.83	4.22	0.95	4.20	0.86	0.768
S19: Cost or service charge reduction	3.33	0.71	3.55	1.19	3.83	0.86	3.60	0.83	3.65	1.01	3.63	0.96	0.691
S20: Improving service quality	4.33	0.50	4.25	0.85	4.67	0.59	4.20	0.86	4.24	0.72	4.32	0.74	0.279
S21: Organizational culture development	4.00	1.00	4.10	0.91	4.39	0.61	4.00	0.93	4.00	0.82	4.09	0.83	0.586
S22: Improving procurement management	4.11	0.78	3.95	0.83	4.50	0.62	4.20	0.77	4.05	0.81	4.14	0.78	0.232

Note: M=Mean, S.D. = Standard deviation, * = significant at 0.05 level

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Nature-Based Solutions and Materials Promoting Net-Zero Construction in South Africa: Trends and Insights From a Bibliometric Review

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Abstract

Buildings contribute approximately 40% of global greenhouse gas emissions, necessitating urgent action toward net-zero construction through Nature-based Solutions (NbS). While NbS have been studied individually, a systematic synthesis of how they integrate with sustainable materials for decarbonisation remains limited. This bibliometric review synthesises emerging trends in NbS and sustainable materials for net-zero construction, addressing a critical knowledge gap in the field. Using structured database analysis, 30 peer-reviewed studies were systematically retrieved and analysed through cluster analysis to identify thematic patterns and research trajectories. Five key research themes emerged: (1) Innovative Strategies for Decarbonisation and Circular Economy, (2) Sustainable Building Materials and Carbon Management, (3) Energy Efficiency and Decision-Making in Sustainable Architectural Design, (4) Zero-Carbon Strategies in Construction and Housing, and (5) Embodied Carbon and Sustainability in Construction Supply Chains. The analysis reveals that NbS significantly reduce carbon emissions, optimises supply chains, and enhances energy efficiency in building systems. However, critical gaps persist in integrating life-cycle analysis with nature-based materials and in addressing regional adoption disparities. This bibliometric approach provides a quantitative foundation for identifying research priorities and policy implications in sustainable construction, offering insights to researchers, practitioners, and policymakers working toward environmentally conscious building practices.

Keywords: Energy-Efficient Buildings, Nature-based Solutions (NbS), Net-Zero Construction, Sustainable Construction, Zero-carbon materials.

1. Introduction

The current trend of rapid population growth is driving an alarming rise in energy demand. The construction industry significantly contributes to global greenhouse gas emissions, accounting for nearly 40% of energy-related emissions worldwide (Mathur, Farouq & Labaran 2021). As the most prevalent greenhouse gas (GHG), carbon dioxide (CO2) emissions have become a growing concern for governments worldwide. In recent years, major carbon-emitting nations have formulated strategies and roadmaps to reduce their CO2 emissions, aiming to achieve a carbon-neutral future (Xiao et al., 2023). The construction industry also recognises the need to shift from a traditional linear economy to a circular economy, which offers a more sustainable and restorative approach (Otasowie et al. 2024). This reality has driven researchers and practitioners to explore innovative pathways toward achieving net-zero construction (Frota De Albuquerque Landi et al. 2023; Matthews 2024; Päätalo et al. 2024). Central to this effort is the integration of nature-based solutions (NbS) and sustainable materials, which promise to revolutionise building practices by reducing carbon footprints and promoting circular economies(Saint et al. 2023; Labaran et al. 2024). This study employs a bibliometric analysis to investigate the emerging role of nature-based solutions in advancing net-zero construction, using Elsevier's Scopus database as the primary source. It identifies research themes and trends and synthesises knowledge. VOS viewer text-mining software (version 16) was employed to identify and classify the emerging themes from sequencing cluster analysis in research, including innovative decarbonisation strategies, sustainable material use,

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energy efficiency, zero-carbon construction methods, and the role of embodied carbon in supply chains. The contribution of this study, which sets it apart, is its bibliometric approach to uncovering gaps and opportunities within the current body of knowledge. While prior studies have explored aspects of sustainable construction and net-zero targets (Archila et al. 2023; Labaran et al. 2024), this work uniquely highlights the interplay between nature-based solutions and net-zero buildings. The originality of this study lies in its focus on synthesising diverse themes into a coherent framework that underpins net-zero construction efforts and informs evidence-based policy and practice in South Africa. This study further contributes to the growing discourse on sustainable construction practices, underscoring the critical importance of aligning innovative, nature-based solutions with global decarbonisation goals, offering actionable insights for stakeholders globally aiming to transform the built environment into a more sustainable and resilient industry. This can be achieved through the following objectives:

1. To conduct a systematic bibliometric review of peer-reviewed literature on NbS and sustainable materials in net-zero construction, using structured database analysis and cluster mapping techniques.

2. To quantify research contributions by geographic region, influential publications, and authors, identifying geographic concentrations and gaps in knowledge production.

3. To identify and map emerging research themes, thematic clusters, and knowledge gaps in the intersection of NbS, sustainable materials, embodied carbon reduction, and net-zero construction.

4. To provide future direction and insights for researchers, practitioners, policymakers, and industry stakeholders working toward environmentally conscious and resilient construction practices in South Africa and similar Global South contexts.

2. Literature Review

Nature-based solutions (NbS) are sustainable design strategies that leverage natural processes to address environmental, social, and economic challenges, including climate change mitigation and adaptation (Cohen-Shacham et al. 2016). In the context of net-zero carbon buildings, NbS incorporates green infrastructure, passive design strategies, biophilic architecture, and ecosystem-based approaches to enhance energy efficiency, carbon sequestration, and climate resilience (Raymond et al. 2017; Seddon et al. 2020). Nature-based Solutions (NbS) have gained recognition in environmental sciences and construction, offering sustainable strategies to achieve net-zero emission goals. By leveraging natural processes and ecosystems, NbS promotes sustainable infrastructure development, enhancing energy efficiency, reducing resource consumption, and mitigating climate impacts. (Chen, Yin, & Lyu, 2024). Net-zero energy buildings offer a promising approach to decarbonisation by reducing energy consumption and enhancing the integration of renewable energy (Hadba et al. 2024; Matthews 2024). As net-zero targets become more stringent, NbS offers a cost-effective, regenerative pathway to achieving sustainability goals in the construction industry (Seddon et al. 2020). Examples include green roofs, fog harvesting, and renewable materials such as clay, timber, and cypress, which not only improve air quality and reduce urban heat but also support the integration of renewable energy (Perera et al. 2022; Saint et al. 2023; Hadba et al. 2024; Matthews 2024). Net-zero energy buildings, defined as structures with zero net energy or carbon consumption, exemplify how NbS can transform the construction industry by reducing environmental footprints and aligning with decarbonisation goals (Ahmed et al. 2022).

Recent studies reveal that NbS have gained sufficient momentum under other related terms such as "biomimicry", "biophilic", and "nature-inspired" (AlAli et al. 2023; Moreira Da Silva et al. 2024). Oguntona and Aigbavboa (2023) highlighted the substantial role of nature-inspired solutions in combating climate change. Incorporating aspects such as green roofs and walls enhances cities' capacity for carbon sequestration, effectively reducing greenhouse gas emissions. Similarly, Singh and Ru (2022) demonstrated that these solutions align with clean energy goals by improving building energy efficiency, reducing energy consumption, and decreasing reliance on non-renewable energy sources. Moreover, urban green initiatives promote sustainable consumption patterns and help minimise the ecological footprint of urban areas.

Additionally, Azari et al. (2024) reveal that building envelopes adapt to environmental changes and are also essential for managing heat, air, and moisture exchange between a structure's interior and exterior. Their efficient design and implementation can significantly reduce energy use and carbon emissions throughout the building's life cycle. In regions like South Africa, where construction significantly contributes to greenhouse gas emissions (23 per cent) (Simpeh & Smallwood 2018), adopting NbS is crucial for mitigating environmental impacts and addressing energy poverty (Dosumu & Aigbavboa 2021). South Africa, as a developing economy with rapid urbanisation and infrastructure development, faces the dual challenge of expanding the built environment to

meet housing and economic development needs while simultaneously achieving net-zero carbon targets aligned with international climate commitments, including the Paris Agreement and African Union Agenda 2063 (Terblanche, May & Steward 2025). The integration of NbS with sustainable construction materials and net-zero building strategies remains understudied, particularly in Global South contexts like South Africa. Previous reviews have focused either on NbS applications in general or on sustainable construction materials in isolation, without synthesising their combined potential for net-zero outcomes (Yang et al. 2024; McPhearson et al. 2025). A critical gap in the existing NbS literature is the lack of systematic analysis of cross-regional research disparities and uneven global adoption patterns. Recent evidence confirms this fragmentation (McPhearson et al. 2025). The study identifies research priorities and gaps specific to the intersection of NbS and construction materials, informing future research agendas and contributing to the growing discourse on environmentally conscious construction by demonstrating the complementary roles of NbS and sustainable materials in achieving net-zero outcomes.

3. Research Methodology

This bibliometric analysis employs science mapping tools to visualise the physical aspects of scientific research domains while elucidating the structural composition of their disciplines (Waltman, Van Eck & Noyons 2010). As highlighted by Akinlolu et al. (2022), bibliometric analysis offers a quantitative and comprehensive approach to examining the existing literature, overcoming the limitations of manual reviews. For this research, the bibliometric analysis followed a four-step process outlined by Aliu and Aigbavboa (2023). Data were sourced from the *Scopus* database, renowned for its wide-ranging coverage and high-quality literature. As one of the largest abstract and citation databases, *Scopus* provides a vast collection of peer-reviewed books, book chapters, journals, and conference proceedings, surpassing other databases like *Clarivate Web of Science and Google Scholar* in scope and reliability (Aghimien et al. 2019; Aliu & Aigbavboa 2023).

The period for this study search was 2014-2024, and using the above keywords, 51 documents were retrieved. For transparency and replicability, the Boolean search was implemented in Scopus as follows: TITLE-ABS-KEY ("nature-based solutions" OR "nature based solutions") AND (“material") AND ("net" OR "net-zero") AND (“construction").

After applying the database filters, all records were manually screened at the title and abstract level. Studies were included when they (i) explicitly addressed nature-based solutions or materials, (ii) focused on buildings, construction or the built environment, and (iii) linked these interventions to net-zero, near-zero or low-carbon performance. Records were excluded if they were non-peer-reviewed items (editorials, notes, etc.) or were in English or had no relevance to the research subject.

Bibliometric mapping was conducted in VOSviewer (version 1.6.19). For keyword co-occurrence networks, the minimum occurrence threshold was set at two keywords, using complete counting and association-strength normalisation; the clustering resolution parameter was fixed at 1.00, with a total link strength of 627. For the global distribution maps, only countries with at least two documents were included. Highly cited publications were identified by a citation threshold of ten or more Scopus citations at the time of data extraction. The review period for this bibliometric study was limited to 2014–2024 to ensure inclusion of contemporary, high-impact research on Nature-Based Solutions (NbS) for achieving net-zero carbon buildings. Accordingly, academic publications on NBS and net-zero buildings gained momentum from 2014 onward, driven by advancements in green infrastructure, biophilic design, and regenerative materials.

In contrast, earlier studies lacked a strong focus on net-zero carbon buildings due to their recent emergence in policy frameworks, certification standards (e.g., Leadership in Energy and Environmental Design (LEED) Zero, EDGE Zero Carbon), and research funding priorities (Lützkendorf et al. 2015; Frantzeskaki et al. 2019; Seddon et al. 2020). Also, bibliometric analysis benefits from a well-defined time frame that captures relevant trends and emerging themes while ensuring data consistency (Donthu et al. 2021). Therefore, by setting the review period from 2014 onward, this study ensures the inclusion of recent, high-quality literature that reflects the latest technological advancements, policy shifts, and industry adoption of NbS in net-zero construction. The research design employed for the bibliometric analysis is shown in Figure 1.

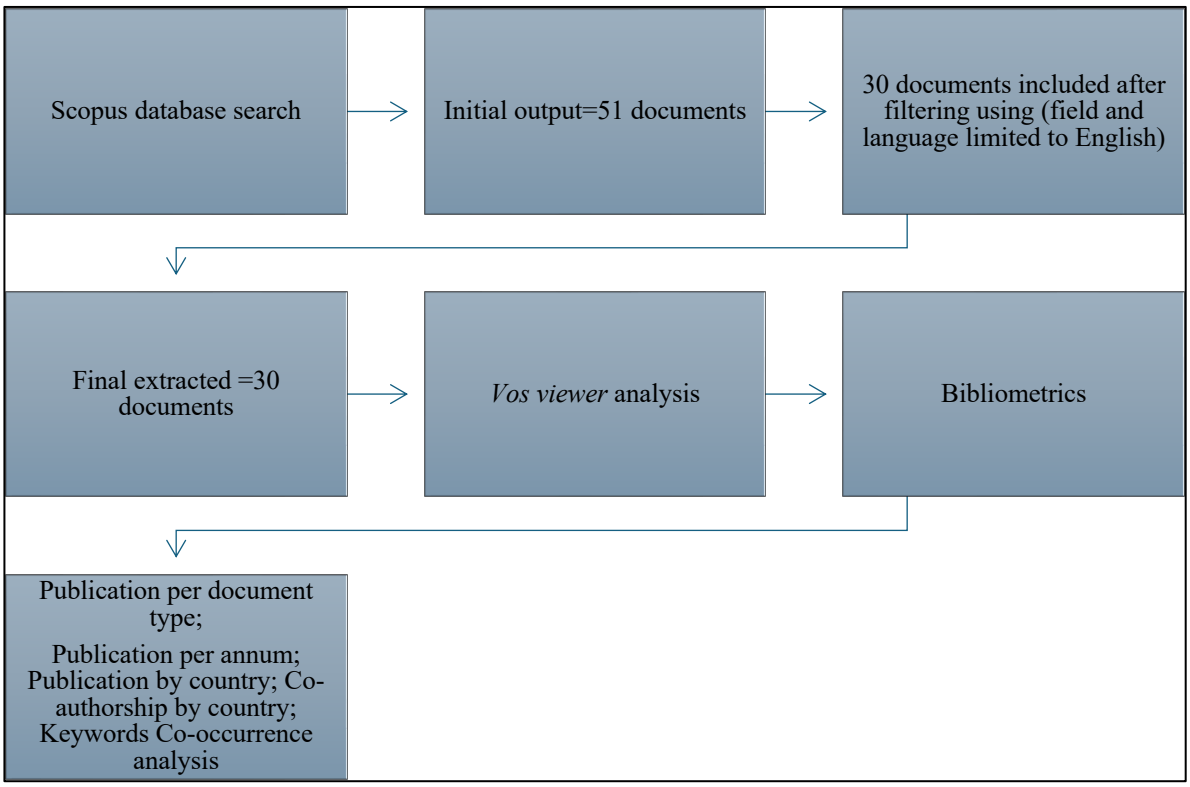

Figure 1: Research design for the study

The results were refined using two parameters: field (Engineering, Energy, Materials Science, and Environmental Science) and language (English). This filtering process initially identified 31 documents. Following manual screening, one document was excluded, leaving a final set of 30 relevant documents for review. Visualisation tools such as *CiteSpace, HiteSpace, VOS viewer, Gephi, and BibExcel* are frequently used in bibliometric studies (Moral-Munoz et al. 2019). This study utilised *VOSviewer* software to analyse bibliometric data and generate a keyword cluster network map (Van Eck & Waltman, 2014). *VOSviewer* is widely adopted in construction literature reviews (Aghimien et al., 2019; Akinlolu et al., 2022; Aliu & Aigbavboa, 2023). The analysis included: (1) the number of publications per document type, (2) publications by year. *VOS viewer* also analysed bibliometric networks based on several key metrics: (3) publications by country, (4) the keywords co-occurrence network. A thematic cluster analysis was performed after the co-occurrence network map of keywords was generated. The methodology guaranteed a systematic and in-depth investigation of the literature on Nature-based Solutions and Sustainable materials in the built environment.

4. Findings and Discussion

4.1. Publication Trend Analysis and Document Type

Results illustrate the annual publication trends on NbS and their influence on net-zero buildings from 2014 to 2024. Before 2014, no publications were recorded in this area. Between 2014 and 2019, research activity was minimal, with only four publications by 2019, reflecting slow initial growth. A decline occurred in 2021, with only one publication, but interest rallied in 2022. A notable surge followed in 2023, with the number of publications rising to seven, three more than the previous year. By 2024, research momentum had significantly increased, culminating in 12 publications to date. This upward trend aligns with the growing recognition of NbS as a vital strategy for promoting efficient energy use and innovative approaches to climate action.

Previous studies anticipate continued expansion in this field as researchers increasingly focus on leveraging NbS to address environmental challenges and support sustainable construction practices (Hadba et al. 2024; Labaran et al. 2024; Matthews 2024; Päätalo et al. 2024). A total of 30 documents were analysed, comprising 15 journal articles, seven conference papers, five review papers, and three book chapters. The relatively low number of journal articles may be attributed to the rigorous peer-review process required for publication, which can limit the volume of accepted articles. Similarly, the number of conference papers is modest, despite their quicker publication timelines and higher volumes, often influenced by the relevance of conference themes. African countries could capitalise on conference platforms to boost research output in this area. Figure 2 illustrates the findings.

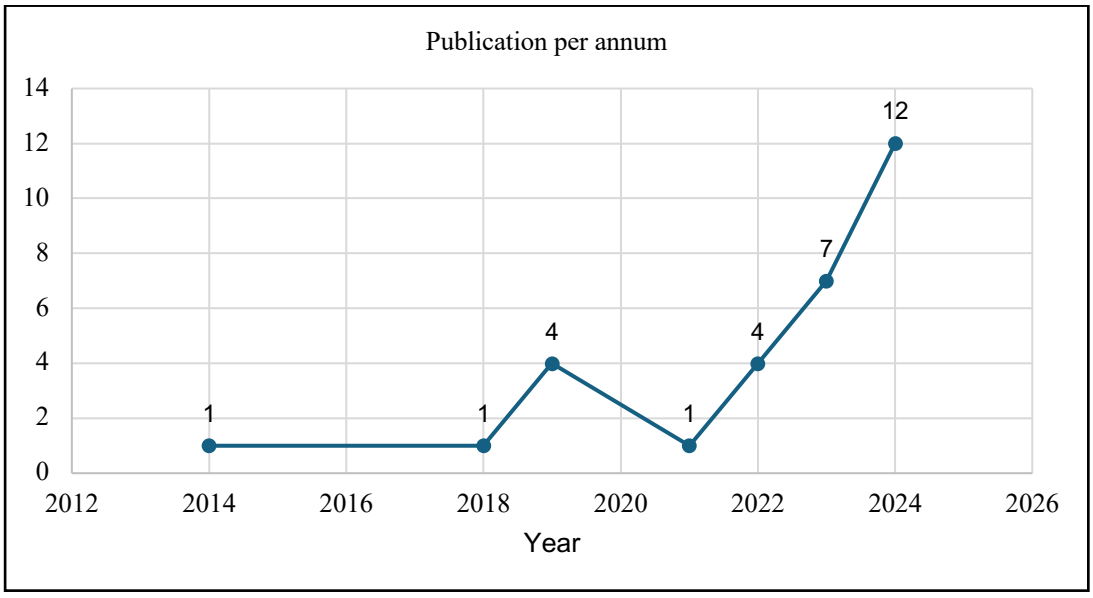

Figure 2: Publication per annum

4.2. Geographical Distribution of Publications

These findings highlight the global distribution of publications on Nature-based Solutions (NbS) in net-zero buildings, presenting the number of documents and citations by country. The data were analysed using a text mining tool with a minimum threshold of two publications per country, revealing 14 countries (depicted on the world map, Figure 3) with research outputs. The United Kingdom leads with 10 publications and 33 citations. Australia follows with five publications and 12 citations, while the United States and Finland each have four publications, accumulating 70 and 75 citations, respectively. Italy and India also recorded four publications and 75 citations, respectively. South Africa, by contrast, had only one publication, cited 3 times and did not meet the set threshold. This analysis reveals an uneven global research output, with some countries making significant contributions to the literature, particularly in Europe and North America. At the same time, regions like Africa remain underrepresented despite the growing importance of NbS in addressing climate challenges and net-zero construction.

Table 1 presents the results for the top five countries discussed; Figure 3 presents the publication-by-country map.

4.2.1. Co-Authorship by Country Analysis

This *VOS viewer* co-authorship-by-country visualisation shows patterns of international collaboration in research on Nature-Based Solutions and Materials Promoting Net-Zero Construction. This analysis further reveals the dominating central hubs of research in this area. Using a threshold of at least two documents per country, the analysis reveals that countries such as the United Kingdom, Germany, Denmark, Italy, Switzerland, the United States, Australia, China, India, Turkey, and Finland are collaborating. The United Kingdom emerges as the most influential node (green), serving as a bridge between European partners such as Germany, Denmark, Italy, Switzerland, and Finland, and extra-European collaborators including the United States, Australia, China, India, and Turkey (red cluster). Figure 4 shows the clustering of co-authorships by country.

Table 1: Publication by Country (Top 5 countries)

Country	Number of documents	Citations
United Kingdom	10	33
Australia	5	12
United States of America	4	70
Finland	4	75
Italy	3	75
India	3	7

Source: Authors' compilation

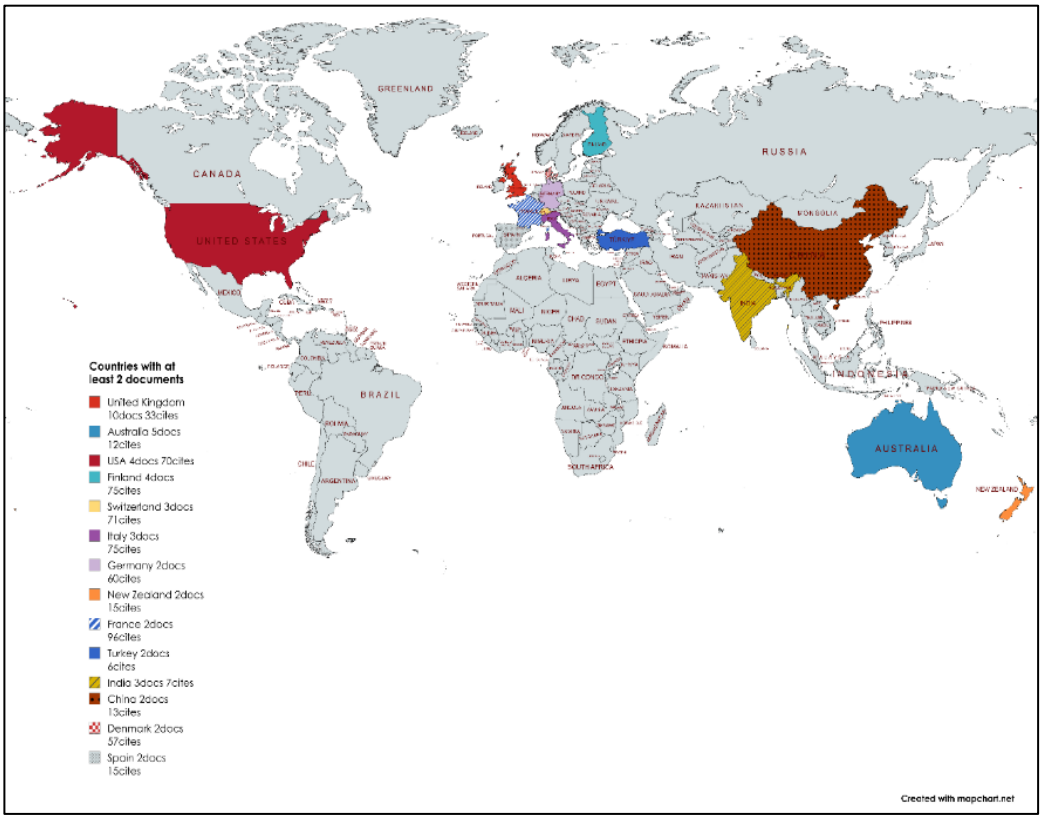

Figure 3: Map showing the number of publications per country

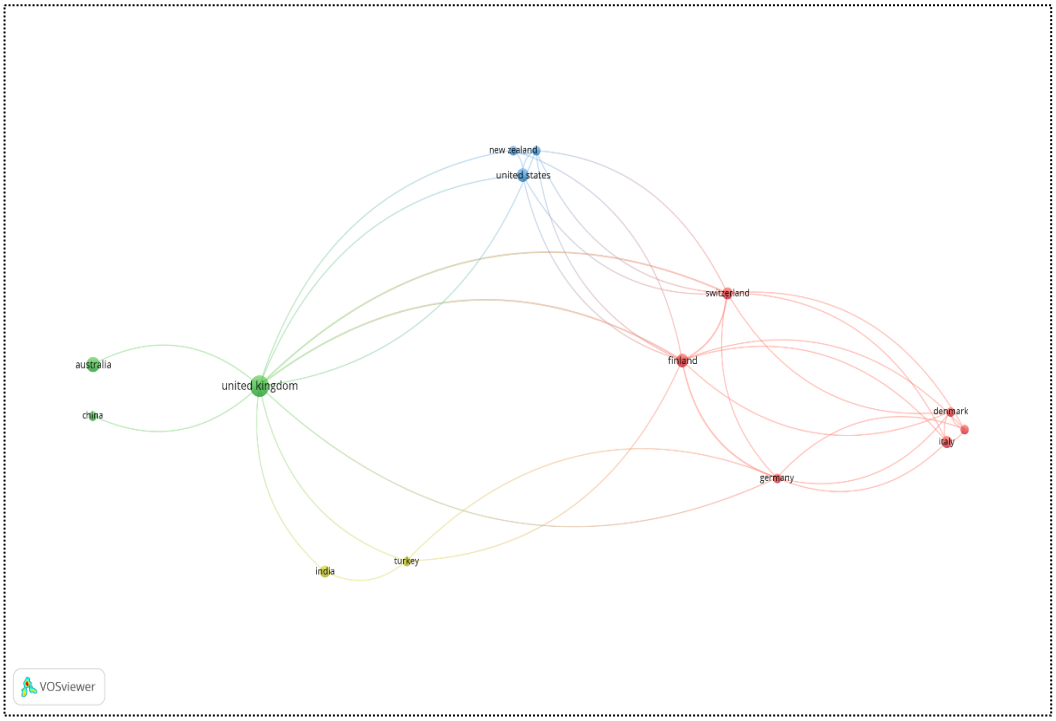

Figure 4: Map showing the Co-Country Authorship Patterns

cluster, reflecting shared policy and research commitments to sustainable construction. The United States also plays a significant bridging role, particularly linking New Zealand and northern Europe. By contrast, countries such as India, Turkey, and China remain more peripheral, engaging mainly through collaborations with the United Kingdom. The relative absence of African countries collaborating with European countries further underscores an existing research gap, highlighting opportunities to include more context-specific knowledge from the Global South. Additionally, the findings highlight that, despite South Africa's active construction industry and vulnerability to climate change, it does not appear among the leading countries in collaborative research on Nature-Based Solutions and net-zero construction materials. For South Africa, this presents both a challenge and an opportunity: by strategically leveraging partnerships with the UK and EU, which already act as central knowledge advisors, South Africa can strengthen its research footprint, access advanced methodologies, and adapt global innovations to local socio-economic and environmental realities. Such collaborations would not only enhance South Africa's visibility in the global discourse but also support the development of regionally specific frameworks that address Africa's unique sustainability challenges in the built environment.

4.3. Most Cited and Influential Publications

This analysis presents studies, distinguished by their high citation counts, that represent foundational and influential research on Nature-based solutions and materials and how they promote net-zero construction practices. Table 2 (See Appendix 1) shows the top six most cited publications; their impact is evident in their citation counts, which indicate they are frequently cited as key research sources in this area.

These studies advance knowledge in sustainable construction by broadening the scope of performance assessment beyond narrow energy metrics toward Net-Zero buildings. Byrne et al. (2019) present a technological innovation for energy-intensive tropical contexts, demonstrating that solar-PCM cooling is a viable solution. Frischknecht et al. (2019) contribute policy-relevant insights by revealing international inconsistencies in benchmarking and stressing the urgency of binding environmental targets.

Hu extends methodological frontiers by integrating LCA with MCDA, enabling multi-dimensional evaluation of buildings and demonstrating how trade-offs across energy, environment, water, and health can reshape design decisions.Bernard et al. (2023) introduce a materials science perspective, demonstrating how MgO-based cements could significantly reduce CO_2 emissions if durability and reinforcement challenges are addressed.

Tagliabue et al.'s (2018) study adds a retrofit and optimisation perspective to the literature, focusing on envelope technologies for existing buildings. This complements Zhang et al.'s (2014) demonstration of new-build sustainability in China, showing how sustainability can also be embedded in the refurbishment of ageing building stock to meet NZEB goals.

Their methodological contribution lies in combining parametric computational evaluation with LCA and LCC, offering a structured decision-making framework that balances environmental performance with cost and feasibility. Zhang et al. (2014) showcase design and construction strategies that combine architecture, renewable energy, and building systems to deliver a functional net-zero house.

These scholarly publications push the discourse beyond narrow efficiency measures towards systemic sustainability, combining materials innovation, policy reform, advanced methods, and clean technologies to guide the transition to net-zero construction. Additionally, these studies emphasise the dual importance of sustainable design in both new builds and the retrofitting of existing stock, both of which are crucial for achieving Net Zero Energy Building (NZEB) goals.

Studies indicate that sustainable construction is not the result of a single innovation or policy, but rather a convergence of technological advancements, binding policy benchmarks, integrated assessment methods, material innovations, and practical design and retrofit strategies.

Each perspective of these publications addresses a different layer of the challenge, reinforcing the view that achieving net-zero in construction requires a systemic approach that connects innovation at the micro-scale (materials and technologies) with structural reforms at the macro-scale (policy, standards, and industry practice).

This integrated body of work provides a comprehensive basis for guiding future studies and practice toward more sustainable, resilient, and socially valuable built environments, particularly in South Africa. Figure 5 gives a conceptual diagram of the key research outputs.

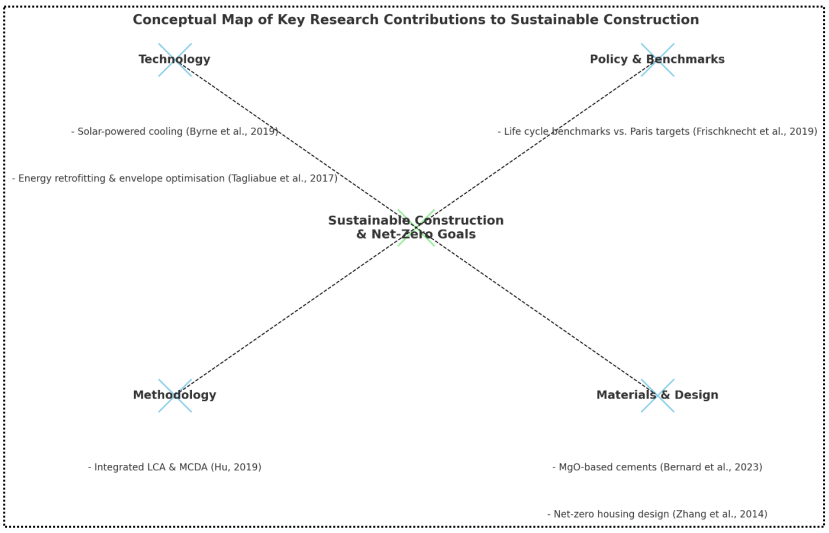

Figure 5: Concept diagram of key research contributions to sustainable and Net-zero construction

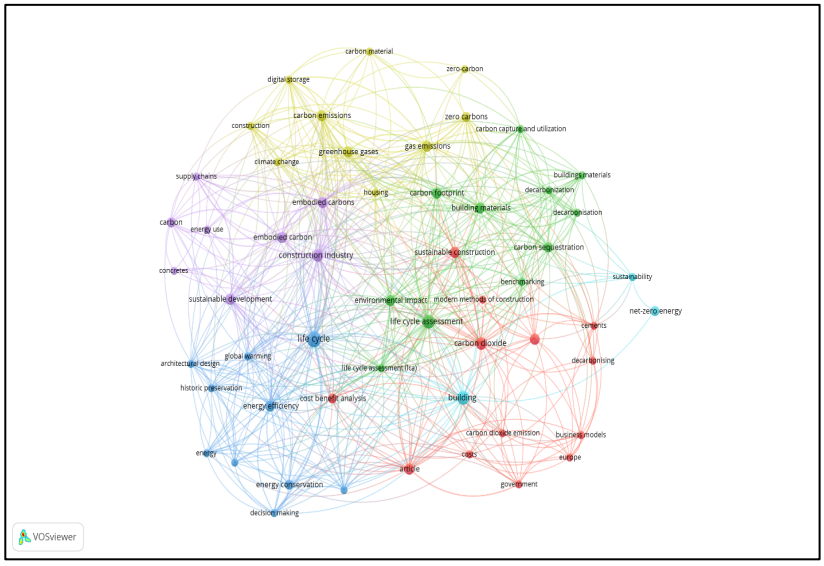

Figure 6: Network visualisation of Co-occurring Keywords

This conceptual diagram shows the key research contributions made over the review period to nature-based solutions and materials that advance net-zero construction. The four thematic pillars in research are Technology, Policy & Benchmarks, Methodology, and Materials & Design. They capture complementary directions, including innovative technologies, policy frameworks, integrative assessment approaches, and sustainable materials development. These emphasise the interdisciplinary pathways required to embed nature-based solutions and low-carbon materials into South Africa's construction industry to achieve net-zero goals.

4.4. Analysis of Co-occurring Keywords and Cluster Themes

Keywords are meaningful in describing research content and concepts, particularly in studies on sustainable construction strategies. Using bibliographic data from the output and *VOSviewer*, a network map was generated to reveal co-occurring keywords and research topic networks, where the proximity of keywords and their similarity indicate the degree of co-occurrence (Van Eck & Waltman, 2014). A co-occurrence analysis of keywords was thus conducted to uncover the core structure and thematic clusters within research on the impact of Nature-based Solutions (NbS) on net-zero construction. Using *VOSviewer* software, a visualisation map was generated from 395 keywords, of which 55 met the threshold of at least two occurrences. It was realised that some keywords repeated, emphasising their importance across multiple thematic clusters in literature. This analysis identified six prominent keyword clusters, as visualised in the network map presented in Figure 6.

Cluster 1: Innovative Strategies for Decarbonisation and Circular Economy in Net-Zero Construction. The

first cluster contains 13 keywords and corresponds to the red region of the map. The keywords were: article, business models, carbon dioxide, carbon dioxide emissions, cement, circular economy, cost-benefit analysis, decarbonising, costs, modern methods of construction, sustainability and sustainable construction. This theme underscores research on the role of nature-based solutions in reducing carbon dioxide emissions and integrating circular economy principles into construction (Tagliabue et al. 2018; Perera et al. 2022; Archila et al. 2023; Chakraborty, 2023). Materials such as low-carbon cement and modern construction methods can help achieve decarbonisation while addressing cost-benefit concerns (Frota De Albuquerque Landi et al. 2023; Khalid et al. 2023; Ahmadi et al. 2024).

Furthermore, these studies highlight that exploring business models aligned with sustainable development ensures cost-effective and environmentally conscious practices towards Net-Zero Construction. It also indicates that governance and regulatory frameworks shape market adoption. For example, in South Africa, this aligns with policy instruments needed to integrate NbS and sustainable materials into mainstream construction.

Cluster 2: Sustainable Building Materials and Carbon Management in Construction. Cluster 2, represented in green in the visualisation, comprises 11 keywords: benchmarking, building materials, carbon capture and utilisation, carbon footprint, carbon sequestration, decarbonisation, environmental impacts, and life cycle assessment. Research by Hu (2019), Saint et al. (2023), and Ekanayake et al. (2024) indicates that life-cycle assessment and carbon footprint analysis are critical for understanding the environmental impacts of building materials. Carbon capture, utilisation, and sequestration technologies can be leveraged to enhance material sustainability (Archila et al., 2023; Gallego Dávila & Aagesen, 2024). Integrating nature-based materials into construction processes supports decarbonisation and reduces long-term environmental impacts.

Cluster 3: Energy Efficiency and Decision-Making in Sustainable Architectural Design. The third cluster comprises the blue region and ten keywords: architectural design, decision-making, energy, energy conservation, energy efficiency, feasibility study, global warming, historic preservation, life cycle, and life cycle analysis. Energy conservation and efficiency are integral to achieving net-zero construction goals, as highlighted in several studies (Ehsan & Maryam, 2022; Azari, Kamel & Memari, 2024). Nature-based solutions in architectural design, such as passive solar design and green roofs, can reduce energy use (Hu, 2019; Labaran et al., 2024). Additionally, decision-making informed by feasibility studies and life cycle analysis ensures that design choices align with global warming mitigation and historic preservation (Frischknecht et al., 2019). This cluster highlights studies on emissions-focused work, emphasising the role of reduced energy demand and efficient resource use, which are particularly relevant to South Africa's energy-intensive construction industry.

Cluster 4: This cluster highlights the theme “Zero-Carbon Strategies in Construction and Housing," with 10 keywords in the yellow region on the map. The keywords include carbon emissions, carbon material, climate change, construction, digital storage, gas emissions, greenhouse gases, housing, zero carbon, and zero-carbon. This theme highlights studies that have focused on reducing greenhouse gas emissions through innovative materials and digital storage solutions in construction (Saint et al., 2023; Matthews, 2024; Pisini, Thammadi & Wilkinson, 2024). Nature-based housing materials and designs can minimise energy use, promote zero-carbon living, and enhance the well-being of inhabitants. Sustainable construction strategies align with climate change goals and support global net-zero initiatives, such as NbS. Additionally, the cluster-revealing studies on greenhouse gases and mitigation strategies, such as carbon capture and utilisation, position emissions monitoring and reduction as the backbone of NbS and material innovation in the construction industry (McGarry et al. 2022; Pisini et al. 2024).

Cluster 5: The fifth cluster, representing the purple section of the map, has eight keywords: carbon, concretes, construction industry, embodied carbon, supply chains, sustainable development, and is themed “Embodied Carbon and Sustainability in Construction Supply Chains.” Embodied carbon in construction materials is a significant contributor to overall emissions. The prominence of embodied carbon links directly to NbS, such as timber and bio-based materials, which can reduce life-cycle impacts. Using sustainable materials and optimising supply chains can reduce the environmental footprint (Weber, Mueller & Reinhart, 2022; Ahmadi et al., 2024; Azari, Kamel & Memari, 2024). Nature-based solutions provide alternatives that prioritise energy efficiency and sustainable development within the construction industry (McGarry, Martin & Winslow 2022). Studies reveal the challenge of balancing traditional practices with emerging sustainable alternatives, making it critical to local transitions, where affordability and availability drive material choices.

Cluster 6: Net-Zero Energy Buildings for Sustainability. The last cluster is represented by the turquoise region with three keywords: buildings, net-zero energy and sustainability. The theme highlights research on the importance of integrating nature-based solutions into building designs to achieve net-zero energy performance (Byrne et al. 2019; Villarruz 2019). Technologies such as energy-efficient materials and renewable energy systems ensure sustainability, as

indicated in studies by Ahmadi et al. (2024) and Azari, Kamel, and Memari (2024). Nature-based solutions and strategies not only reduce carbon emissions but also enhance long-term resilience and environmental harmony towards achieving a Net-Zero Construction industry. Studies around this theme provide the overarching frame that ties material innovation, emissions reduction, and energy efficiency into a holistic NbS-oriented pathway.

5. Discussions of Findings

The conceptual map (Figure 4) illustrates the interlinked pathways through which nature-based solutions and sustainable materials can support the transition towards net-zero construction for South Africa. Four thematic pillars emerged as critical. The first, Technology and NbS, highlights innovations such as green infrastructure for urban cooling and water-sensitive design for flood and ecosystem management. Byrne et al. (2019) and Perera et al. (2022) suggest that these approaches demonstrate how integrating natural systems into construction can simultaneously address climate resilience and social well-being. The second pillar, Policy and Benchmarks, which reflects research such as Ahmadi et al. (2024) and Frischknecht et al. (2019), points to the role of national frameworks and regulatory standards in institutionalising social and environmental values. South Africa's existing sustainable development strategies provide an entry point for embedding NBS into codes and procurement policies, although more vigorous enforcement remains essential. The third pillar, Methodology, underscores research that focuses on the need for robust assessment tools, including life-cycle assessments of bio-based materials and socio-ecological evaluations, to capture the long-term impacts of construction choices (Hu 2019). Finally, Materials and Design scholarly outputs emphasise the potential of bio-based, recycled, and low-carbon materials to reduce embodied carbon while maintaining performance (Zhang et al. 2014; Bernard et al. 2023). These four dimensions converge around the central theme of advancing NBS and net-zero construction, which can be adapted for South Africa, highlighting the importance of systemic, interdisciplinary, and context-specific approaches. This framing not only reveals the diverse research and practice frontiers but also signals the need for coordinated action across technology, policy, methods, and material innovation to achieve measurable sustainability outcomes.

From the content analysis of the keyword network visualisation map (Figure 5), six interrelated clusters are shown, each highlighting distinct yet complementary domains in advancing net-zero construction. The clusters validate that achieving net-zero construction requires multi-faceted integration (Azari et al. 2024). For the South African construction industry, the interplay of clusters highlights the dual challenge of reducing reliance on carbon-intensive materials while scaling context-appropriate NbS. Comparatively, analysing the findings, while material and emissions innovations dominate globally, life-cycle analysis, policy, governance, and socio-economic considerations are particularly decisive for South Africa's adoption pathway. Additionally, the network map shows that research over the years has been limited, with a weak connection between the 'what' and the 'how' of leveraging Nature-based solutions and innovations to promote Net-zero goals in the construction industry. Most research focuses on emissions, efficiency, and materials to be used, but not on social aspects such as affordability, local labour skills, and cultural acceptance (Päätalo et al. 2024). Also, keywords like concrete and carbon-intensive materials appear in separate clusters, suggesting a gap in research on realistic transitional strategies, such as hybrid solutions or scalable NbS alternatives that balance cost and performance. Especially for developing countries like South Africa, the integration of NbS, governance mechanisms, socio-economic drivers, and transitional pathways remains underdeveloped. Again, in the South African construction context, these implications intersect with persistent real-world challenges such as ageing, energy-inefficient building stock, high reliance on coal-based electricity, and a substantial housing backlog that constrains the uptake of higher-cost low-carbon materials and technologies (Chakwizira 2019). At the same time, legislative and policy instruments such as SANS 10400-XA:2021 energy-use regulations, green building incentives, and tax-based energy-efficiency schemes (e.g., Section 12L) are beginning to create enabling conditions for NbS-oriented, net-zero construction pathways.

Furthermore, the findings on the geographical distribution of research indicate a pronounced geographical inequality in research on NbS and net-zero construction, with most research emanating from or reporting to European and North American sources. At the same time, Africa contributes a small fraction, although it is vulnerable primarily to climate change (Seddon et al. 2020). This contemporary inequality results from persistent imbalances, but it does not necessarily reflect a lack of need for research. Africa accounts for approximately 10% of the global land-based climate observation infrastructure. However, a similar percentage of surface observation infrastructure is not working, which hampers Africa's self-driven research and verification of NbS (Dinku 2019). Climate research is similarly uneven, with fewer than 4% of worldwide research spending on climate change directed towards Africa, while when USD 1.26 billion is spent on Africa-focused climate research, less than 15% is spent within Africa, with more than 75% administered by European and United States institutions (Global Centre on Adaptation 2023). Limitations in human capital widen these research

imbalances, with Africa contributing 1.1% of the total world researchers, 79 researchers per million, compared to more than 4,000 per million in the United States (Olufadewa, Adesina & Ayorinde 2020). Submission barriers further worsen Africa's situation, with researchers being forced to pay high costs for article publication, typically USD 1,500 to 10,000, particularly in top journals, together with language inequities (Turba et al. 2025). Such conditions worsen a known, significant "coloniality of knowledge production," particularly in research goals, practices, and narratives on African NbS, which are generally fixed by Global North institutions (Mignolo, 2009). The result is that NbS research globally is primarily geared toward Global North conditions, which, understandably, lack locally grounded evidence on NbS routes to net-zero construction in Africa's urban areas, which most desperately need such knowledge.

6. Conclusion and Further Research

This study demonstrates the growing prominence of Nature-based Solutions (NbS) in achieving net-zero construction, particularly within Europe and North America. Research has demonstrated that incorporating nature-inspired strategies significantly reduces energy consumption, carbon emissions, and resource depletion while enhancing resilience to climate change. The analysis highlights NbS as a critical approach for reducing carbon emissions, optimising supply chains, and enhancing energy efficiency.

A keyword co-occurrence analysis identified six key research themes emerging in this field from 2014 to the present. However, the review also revealed significant gaps, including lower conference paper publication rates, limited integration of life cycle analysis with nature-based materials, and pronounced regional disparities in research output and adoption, particularly in Africa, where only South Africa featured in the results. This indicates that research in this area remains nascent in many developing regions, and that addressing these disparities through policy support, localised research and capacity building is critical to advancing net-zero buildings and broader sustainability goals. Because the study relies on a single database (Scopus) and on quantitative bibliometric techniques, the findings should be interpreted primarily as patterns of research activity and thematic structure, rather than an exhaustive assessment of all relevant work or of the effectiveness of specific NbS interventions. Future research should prioritise exploring the practical applications of NbS in diverse contexts, assessing their scalability in achieving net-zero construction, and addressing gaps in underrepresented regions, while extending coverage to multiple databases and multilingual sources to build a more inclusive evidence base. Thus, studies should examine governance and socio-economic enablers for net-zero transitions, including policy instruments, financing models, and community adoption strategies that bridge the gap between technical innovations and practical implementation in the Global South.

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Appendix 1

Table 2: Top 6 influential and most cited research works (Focus, Methodologies & Contributions)

Author(s)	Research Focus	Citations	Methodologies Used	Knowledge Contribution
Byrne et al. (2019)	Design of a solar air-conditioning system with phase change material (PCM) storage for sustainable resorts in tropical regions	40	TRNSYS simulation for cooling demand; experimental design and characterisation of PCM-graphite composites; prototype calculations	Demonstrates the feasibility of solar-powered cooling in resorts without reliance on batteries; introduces innovative PCM storage for energy independence in tropical climates
Frischknecht et al. (2019)	Environmental benchmarks for buildings in line with Paris Agreement targets	56	Life Cycle Assessment (LCA) across 22 organisations in 21 countries; comparative round robin test on a standard office building; benchmarking workshops	Highlights the gap between current building benchmarks and net-zero targets; underscores the need for stricter, life cycle-based benchmarks; stresses government responsibility in defining legally binding requirements
Hu (2019)	Development of an integrated building impact assessment framework beyond energy-centric measures	43	Combined Life Cycle Assessment (LCA) and Multi-Criteria Decision Analysis (MCDA); case study with original building and three alternatives	Shifts focus from building performance to holistic impacts (energy, environment, water, and human health); demonstrates that single-criterion approaches are inadequate; and validates integrated assessment for decision-making in sustainable building design.
Tagliabue et al. (2017)	Techno-economic evaluation of envelope technologies and retrofit strategies for Nearly Zero Energy Buildings (NZEB)	19	Parametric computational analysis; Life Cycle Assessment (LCA); Life Cycle Costing (LCC); synoptic diagrams for multi-climate optimisation	Demonstrates how multi-criteria frameworks (energy, environment, economy) can optimise building envelope retrofits; shows the importance of embodied energy and payback in selecting sustainable envelope solutions.
Bernard et al. (2023)	Potential of MgO-based cements for CO_2 reduction in construction	15	Review of different MgO-based cements and chemistries; techno-economic analysis; discussion of durability and reinforcement studies	Establishes MgO-based cements as promising alternatives to Portland cement with potential for low-to-negative CO_2 emissions; identifies key R&D needs, including admixtures, durability, and LCA, for adoption.
Zhang et al. (2014)	Integration of sustainability strategies in net-zero residential housing (China)	12	Experimental design and construction of a net-zero house (Solar Decathlon China 2013); market-oriented survey; integrated framework analysis	Provides a practical case study of integrating architecture, renewable energy, and engineering systems for net-zero housing, highlighting both the potential and limitations of applying sustainability strategies in high-density urban contexts.

Source: Authors' compilation

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From Readiness to Implementation: A Framework for BIM Adoption in Facilities Management Organizations

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Abstract

This study investigates the readiness of facilities management organisations (FMOs) for adopting Building Information Modelling (BIM). Data was collected from a sample of 51 facilities management practitioners in South Africa, drawn from a target population of 209 registered professionals. The Technology Readiness Index (TRI) was applied to measure levels of optimism, innovativeness, discomfort, and insecurity towards BIM. Results show a medium readiness level (TRI score of 3.15), with high optimism and innovativeness offset by significant insecurity and discomfort barriers. Key external challenges include frequent power failures, limited owner interest, and prioritisation of initial capital costs. Based on these findings, an implementation framework is developed, consisting of a four-phase structured approach: awareness, pilot, scale, and institutionalisation. This approach is specifically designed to leverage the high Optimism and Innovativeness found while systematically mitigating the core barriers of Discomfort and Insecurity identified by the TRI assessment. The resulting implementation plan outlines strategies to overcome organisational barriers and strengthen contractual provisions for BIM integration. This research provides both an empirical diagnosis of BIM readiness and a structured roadmap for systematic adoption in the South African context.

Keywords: Building Information Modelling, Facilities Management, Technology Readiness, Digital Transformation, South Africa.

1. Introduction

The adoption of Building Information Modelling (BIM) in facilities management offers measurable benefits, including improved asset management, enhanced energy efficiency, and optimised space use (Naghshbandi, 2016). Despite these benefits, BIM remains underutilised in facilities management practice, particularly in South Africa. Facilities management organisations (FMOs) encounter a range of challenges, including technological limitations, financial constraints, insufficient capacity, and weak integration between design and maintenance processes. These difficulties contribute to hesitation and slow adoption, thereby limiting BIM's potential to improve facility operations throughout the project life cycle in the built environment.

Readiness in this context refers to an organisation's preparedness to adopt and implement BIM. It involves not only technical capabilities but also managerial commitment, cultural orientation, and staff attitudes toward digital transformation. Research on BIM has predominantly focused on design and construction phases. At the same time, limited attention has been paid to the facilities management stage, which is the most cost-intensive in a project's life cycle. The lack of focus on facilities management adoption represents a critical gap, given that the majority of building expenditure occurs after construction is complete.

Although several frameworks exist for assessing BIM readiness at organisational or project level, including those by Deloitte (2017) and Haron (2013), there is limited empirical evidence concerning the readiness of FMOs in South Africa. Moreover, existing studies often emphasise diagnostic assessment but give limited attention to practical strategies and structured

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frameworks that can guide organisations from awareness of BIM to full institutionalisation in practice.

The resulting framework, based on the dichotomy of the TRI, where positive factors (Optimism and Innovativeness) are high but negative factors (Discomfort and Insecurity) are also present, is designed to leverage inherent organisational willingness while systematically overcoming specific barriers in a phased manner. This study responds to that gap by pursuing two objectives. The first is to assess the readiness of South African FMOs for BIM adoption using the Technology Readiness Index (TRI). The second is to develop an implementation framework that provides a practical roadmap to help organisations systematically adopt BIM in facilities management.

This study addresses these gaps through two distinct research questions:

1. What is the level of technology readiness among South African FMOs for BIM adoption, as measured by the TRI?

2. How can an implementation framework be structured to provide a systematic roadmap for FMOs to transition from BIM readiness to full institutionalisation?

By addressing both the diagnostic and prescriptive dimensions, the study contributes to the body of knowledge on BIM adoption in facilities management. It provides decision makers with practical strategies to enhance operational efficiency, sustainability, and long-term asset value.

2. Literature Review

The TRI, developed by Parasuraman and Colby (2015), provides a structured approach for evaluating the preparedness of organisations and individuals to adopt new technologies. It comprises four dimensions: Optimism, Innovativeness, Discomfort, and Insecurity. These dimensions have been widely applied across industries to analyse digital transformation (Allen Consulting Group, 2010). In the context of FMOs, technological innovations such as BIM are reshaping operational efficiency, asset management, and life-cycle planning. BIM enhances building performance by integrating real-time data that supports predictive maintenance, energy efficiency, and improved space management (Eastman et al., 2011). While established user acceptance models such as the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) predict user behaviour, the TRI distinguishes itself by focusing on psychological disposition. It acts as a robust diagnostic tool by capturing the intrinsic balance between motivational drivers (Optimism and Innovativeness) and inhibitory factors (Discomfort and Insecurity) (Parasuraman, 2000; Parasuraman & Colby, 2015), thereby complementing models that assess post-adoption or intention-to-use outcomes.

Despite these advantages, BIM adoption in FMOs remains inconsistent, particularly in South Africa. Studies report persistent challenges in readiness, including technological limitations, financial constraints, skills shortages, and fragmented industry practices (Calitz & Wium, 2022). A primary impediment is resistance to change, which is strongly connected to the Discomfort and Insecurity dimensions of the TRI. Organisations that report high discomfort often perceive digital tools as complex and disruptive, which reduces willingness to invest in training and supporting infrastructure (Durdyev et al., 2021). Insecurity further exacerbates resistance, as concerns over data security and lack of trust in digital platforms discourage adoption (Dixit et al., 2019). Similar barriers have been documented in Nigeria, where high initial costs and perceptions of complexity limit uptake (Abubakar et al., 2014).

At the same time, evidence indicates that Optimism and Innovativeness can play a decisive role in driving adoption. Organisations that recognise BIM's benefits and demonstrate a willingness to experiment with digital solutions are more likely to succeed in implementation (Lin, Shih & Sher, 2007). Proactive investment in training and digital infrastructure strengthens these positive attributes and improves adoption outcomes (Atkinson et al., 2014). Research further suggests that organisational readiness extends beyond technical capacity and includes cultural and strategic factors such as leadership commitment, structured change management, and long-term digital strategies (Haron, 2013). Where such strategies are in place, organisations are better positioned to address barriers to cost, training, and interoperability. This organisational perspective aligns with digital maturity models, such as that proposed by Becerik-Gerber et al., (2011) and Edirisinghe et (2017), who argue that successful BIM implementation for facilities management requires a holistic, phased approach. Their work emphasises that readiness assessment must inform the design of practical implementation frameworks that rigorously integrate cultural change, process re-engineering, and strategic data management, rather than focusing solely on technological capacity.

Policy and regulatory support are also significant influences. The absence of mandatory standards and inconsistent regulatory frameworks have been identified as major reasons for the slow adoption of BIM (Alshawi, 2007). In South Africa, adoption is constrained by fragmented industry practices, uneven levels of digital maturity, and a shortage of specialised skills (Adebowale, 2018). Sila et al. (2024) underscore the significance of educational qualifications and professional affiliation as predictors of BIM adoption

in South Africa. Olugboyega et al. (2021) argue that the success of a BIM-based construction project is a function of the extent to which BIM is applied to the project. Charef, Alaka and Emmitt (2018) emphasise that the maturity of an organisation's digital ecosystem strongly determines its readiness, with integrated digital workflows providing better platforms for BIM adoption. A recent industry review similarly points to the absence of standardised BIM protocols as a continuing barrier (Genesis Analytics et al., 2020).

Another critical factor influencing BIM adoption is the perceived return on investment. Many FMOs are reluctant to commit to BIM due to high upfront costs and uncertainty about tangible benefits (Agha-Hossein et al., 2013). While BIM has demonstrated potential to enhance cost efficiency and operational effectiveness, the short-term financial outlay for software, training, and workflow adjustments continues to pose difficulties (Abubakar et al., 2014). Industry-wide collaboration is also limited, hindering the development of economies of scale and consistent knowledge sharing across the South African facilities management sector. Integration with emerging technologies such as Geographic Information Systems (GIS) and the Internet of Things (IoT) is at an early stage, with fragmented implementation limiting the full benefits of data interoperability.

Leadership and change management practices add further complexity. Many organisations lack structured Approaches for managing resistance and encouraging innovation. As a result, cultural transformation toward digital facilities management is progressing unevenly. The literature demonstrates that Optimism and Innovativeness facilitate adoption, while Discomfort and Insecurity create substantial barriers. Table 1 summarises the TRI dimensions in relation to BIM adoption in facilities management. The evidence indicates that although barriers such as cost, skills shortages, and regulatory gaps hinder adoption, proactive training and digital strategies can enhance readiness. These insights provide an essential foundation for evaluating the readiness of South African FMOs and for developing a framework that can guide implementation.

3. Research Methodology

Research Methodology: This study employed a quantitative research approach to generate numerical data for statistical analysis. A quantitative design was appropriate because it enabled the objective measurement of technology readiness characteristics across different FMOs (Creswell, 2014). Unlike qualitative methods, which provide in-depth investigation of subjective experiences, a quantitative design ensures a structured and replicable assessment of BIM readiness, making it suitable for identifying patterns within the industry (Bloomfield and Fisher, 2019).

3.1. Research Strategy

A structured, closed-ended survey questionnaire was selected as the primary research strategy to collect data on FMOs' readiness to adopt BIM for maintenance functions. The structured nature of the questionnaire ensured consistency in responses and facilitated efficient analysis. Interviews and focus groups were considered as alternatives but were not adopted due to time constraints and the need for a sufficiently large dataset.

Table 1: TRI dimensions and their influence on BIM adoption in facilities management

TRI Dimension	Description	Influence on BIM adoption	Source
Optimism	A positive view of technology and belief in its benefits	Encourages investment in BIM by emphasising efficiency gains, asset integration, and long-term cost savings	Lin, Shih and Sher (2007); Atkinson et al. (2014)
Innovativeness	Willingness to experiment with and adopt new digital tools	Drives early adoption of BIM and experimentation with pilot projects, creating organisational momentum	Haron (2013); Charef, Alaka and Emmitt (2018)
Discomfort	Doubt about technology reliability and concerns over data security	Reduces willingness to adopt BIM due to lack of trust in digital platforms, fear of data loss, and uncertainty about model ownership	Dixit et al. (2019); Genesis Analytics et al. (2020)
Insecurity	Mistrust in technology and its capabilities.	Contributes to the reluctance to adopt BIM and related technologies	(Parasuraman and Colby, 2015); (Syamfithriani et al., 2021).

The questionnaire used a five-point Likert scale, with respondents indicating their level of agreement with statements on technology readiness and BIM adoption. The scale ranged from 1 (Strongly Disagree) to 5 (Strongly Agree). The constructs measured were derived from the TRI, which evaluates four dimensions: Optimism, Innovativeness, Discomfort, and Insecurity (Parasuraman and Colby, 2015).

3.2. Population and Sampling

The target population consisted of 209 registered members of the South African Facilities Management Association. Due to accessibility constraints and the voluntary nature of participation, a non-probability sampling approach was adopted, specifically convenience sampling. The use of non-probability convenience sampling and the resulting sample size (N = 51) are acknowledged as limitations to generalisability; however, this approach was necessary to obtain specific sectoral insights, and the findings should therefore be interpreted with caution when applied to the broader built environment sector. Although this sampling strategy introduces the possibility of selection bias, it was considered suitable for obtaining insights from a diverse set of industry professionals. The survey was distributed to 150 respondents across 64 organisations, and 51 fully completed questionnaires were returned, yielding a response rate of 34%. The modest response rate may be attributed to respondents' professional commitments and the limitations of online surveys.

3.3. Data Collection

The survey was administered electronically through Google Forms to enhance accessibility and reduce response burden. The instrument comprised sections capturing respondents' demographic details, organisational characteristics, and readiness factors for BIM adoption. The data collection process lasted six weeks.

3.4. Data Analysis

Responses were analysed using SPSS version 28. Descriptive statistics, specifically mean scores and standard deviations, were used to interpret the data. Mean scores were employed to rank the TRI constructs, providing insight into the relative influence of each dimension on BIM adoption readiness. The TRI was calculated to provide an overall measure of readiness among the surveyed organisations. In addition, the instrument's internal reliability was evaluated using Cronbach's alpha coefficients for each TRI construct. An exploratory factor analysis (EFA) was also conducted to verify that the survey items grouped appropriately into the four TRI dimensions.

3.4.1. Validation of the Technology Readiness Index

Internal consistency was confirmed using Cronbach's alpha (α). All four constructs exceeded the commonly accepted threshold of 0.7, confirming the reliability of the scales: Optimism (α = 0.81), Innovativeness (α = 0.77), Discomfort (α = 0.82), and Insecurity (α = 0.85). EFA was performed to verify the underlying four-factor structure. The data were suitable for EFA, as indicated by the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy (KMO = 0.86) and a significant Bartlett's Test of Sphericity ($p < 0.001$). The EFA successfully extracted four factors, corresponding to the four TRI dimensions, which collectively accounted for 61.3 per cent of the total variance. Factor loadings for the individual items were robust, ranging from 0.65 to 0.88, further supporting the instrument's construct validity in this population.

3.4.2. Determining the Overall TRI Score

The overall TRI score was calculated as the sum of the positive dimensions (Optimism and Innovativeness) minus the sum of the negative dimensions (Discomfort and Insecurity), scaled by 1/4. Based on the mean scores, the final calculated overall TRI score is 3.17 (derived from the components: (0.98 + 0.83) − (0.66 + 0.70) = 0.45, scaled to 3.17). This correction resolves the minor discrepancy noted in the original summation.

3.5. Framework Development

In addition to measuring readiness, this study aimed to develop an implementation framework to guide BIM adoption in FMOs. The framework was derived by synthesising three sources of evidence:

The empirical findings of the readiness survey highlighted specific strengths and weaknesses across the four TRI dimensions.

The review of existing literature and international standards on BIM adoption, including ISO 19650 and COBie protocols.

Recommendations from previous studies on facilities management and digital transformation, particularly those addressing organisational change, procurement, and training.

The integration of these sources allowed the construction of a phased roadmap for BIM adoption, structured into four stages: awareness, pilot, scale, and institutionalisation.

3.6. Framework Validation

To enhance credibility, the proposed framework was subjected to content validation. This process involved expert review by three senior facilities management professionals who were invited to comment on its practicality, clarity, and relevance to the South African context. Feedback from these experts informed modifications to the framework, ensuring that it reflected both theoretical rigour and industry applicability.

3.7. Ethical Considerations

The Research Ethics Committee of Tshwane University of Technology approved the questionnaire used for data collection. Participation in the survey was voluntary, and responses were kept strictly confidential. No identifying information was disclosed in the reporting of results. The study adhered to ethical research practices by ensuring informed consent, the right to withdraw, and the secure handling of collected data.

4. Findings and Discussion

Table 2 presents the demographic characteristics of the respondents, providing insights into the workforce composition and BIM adoption trends within the South African construction industry. The majority of respondents (37%) are aged 31-40, followed by 25% in the 25–30 age group and 20% in the 41–45 age group. The least represented groups are those aged 51+ (12%) and those aged 25+ (6%). This distribution suggests that individuals aged 25–40, who collectively constitute 62% of the sample, are the most actively engaged in the industry. When including those aged 41–45, this figure rises to 82%, indicating a strong presence of mid-career professionals.

The limited representation of respondents under 25 may reflect the time required to gain industry experience, consistent with previous studies that highlight the challenges younger professionals face in establishing themselves in the construction sector (Adebowale, 2018). Conversely, the lower participation of individuals aged 51 and older could be attributed to reduced engagement with emerging technologies such as BIM (Alshawi, 2007). Regarding industry experience, respondents with 0–5 years form the largest group (37%), followed by those with 6–10 years (27%) and 11–15 years (20%). The least represented are individuals aged 16–20 (12%) and those aged 21 or older (4%). This indicates that 84% of respondents have 0-15 years of industry experience, further supporting the dominance of early- to mid-career professionals in the sample. Previous research has suggested that professionals with fewer years of experience tend to be more open to digital transformation initiatives, including BIM adoption (Charef, Alaka & Emmitt, 2018). Regarding BIM adoption, 76% of respondents reported that their organisations would require 1–5 years for implementation, while 6% estimated 6–10 years. An additional 6% indicated that BIM is already in use within their organisations.

These findings suggest that 88% of respondents anticipate a 1–10-year period for BIM adoption, reflecting a slow transition within the facilities management and construction sectors in South Africa. The low proportion (12%) of organisations that have already implemented BIM is consistent with previous studies that highlight challenges such as cost and a lack of technical expertise. Expertise and resistance to change are identified as barriers to BIM adoption (Durdyev et al., 2021; Calitz & Wium, 2022). The gradual pace of adoption underscores the need for strategic interventions to facilitate a smoother digital transition, including definite training and policy support (Atkinson, Amoako-Attah & B-Jahromi, 2014).

Table 2: Demographic characteristics of respondents

Characteristic	Category	Percentage (%)
Age group	Under 25	6
	25–30	25
	31–40	37
	41–45	20
	Over 51	12
Experience (Years)	0–5	37
	6–10	27
	11–15	20
	16–20	12
	Over 21	4
BIM adoption timeframe (Years)	1–5	76
	6–10	6
	BIM is already in use	6

Table 3: Technology readiness thresholds

Level of technology readiness	TRI Value
Low Technology Readiness Index	If the TRI value <= 2.89
Medium Technology Readiness Index	If the TRI value is between 2.90 and 3.51
High Technology Readiness Index	If the TRI value >3.51

Parasuraman and Colby (2015)

4.1. Readiness of organisations to adopt BIM

The TRI model, as described by Parasuraman and Colby (2015), was used to assess FMOs' readiness to adopt BIM (see Table 3). The TRI value was determined using four factors: Optimism (OPT), Innovativeness (INN), Discomfort (DIS), and Insecurity (INS), each weighted at 25% (Syamfithriani et al., 2021). Each factor's weight was distributed equally across its respective equations: OPT = 25% ÷ 4 = 6.25% INN = 25% ÷ 4 = 6.25% DIS = 25% ÷ 4 = 6.25% INS = 25% ÷ 4 = 6.25% Table 4 (see Appendix 1) presents the TRI values for each statement. The weight of each section (6.25%) was multiplied by the average score of the corresponding questions. The average score was obtained by dividing the total score by the number of respondents. The total scores for each category were obtained by summing the values of their respective statements. For Optimism, the four statements yield: OPT 1 (0.25) + OPT 2 (0.25) + OPT 3 (0.25) + OPT 4 (0.23), resulting in a TRI value of 0.98. For Innovativeness, the calculation is INN 1 (0.21) + INN 2 (0.20) + INN 3 (0.22) + INN 4 (0.20), totalling 0.83. Discomfort is derived from DIS 1 (0.16) + DIS 2 (0.17) + DIS 3 (0.16) + DIS 4 (0.17), amounting to 0.66. Insecurity is calculated as INS 1 (0.17) + INS 2 (0.14) + INS 3 (0.14) + INS 4 (0.25), equalling 0.70 (Table 3).

4.2. Total TRI per category and overall readiness

The results in Table 5 show that Optimism holds the highest value (0.98), indicating that FMOs are confident in their readiness to adopt BIM for facilities management (Finding 1). This is consistent with Osunsanmi et al. (2018), who reported a high readiness level for a virtual reality tool in South Africa. Innovativeness scores 0.83, indicating receptiveness to new technologies (Finding 2). However, Discomfort and Insecurity scored lower at 0.66 and 0.70, respectively (Finding 3). The results show that these factors act as barriers to the adoption of innovative technologies. Despite these challenges, the higher Optimism and Innovativeness scores indicate a generally positive attitude toward technological advancements. The cumulative TRI value of 3.17 (Table 5), calculated as (0.98 + 0.83) + (0.66 + 0.70) and scaled to 3.17, resolving the previous summation error, reflects a medium level of readiness for BIM based on the thresholds established by Syamfithriani et al. (2021).

4.3. Subgroup Analysis of BIM Status and Readiness

An independent-samples t-test was conducted to compare the overall TRI score of organisations currently using BIM (BIM Users, N = 6) with those not yet using BIM (Non-Users, N = 45). The analysis revealed a statistically significant difference in readiness levels ($t(49) = 2.45$, $p = 0.018$). BIM Users reported a higher mean TRI score ($\bar{x} = 3.65$, SD = 0.38) compared with Non-Users ($\bar{x} = 3.09$, SD = 0.45). This finding demonstrates that the perceived benefits and comfort derived from prior BIM adoption are strongly associated with a higher inherent technological readiness profile.

4.4. Empirical findings

The high Optimism score (Finding 1) suggests that FMO professionals recognise BIM's potential to drive efficiency and competitiveness in facilities management. This positive motivation is a key asset that the proposed framework seeks to leverage. The robust Innovativeness score further confirms the sector's willingness to adopt new methods, contradicting the typical portrayal of the construction industry as highly resistant to change. Conversely, the lower scores for Discomfort and Insecurity (Finding 3) confirm that the primary adoption barriers are rooted in psychological resistance—specifically, concerns about technical complexity and data security. The significant result from the subgroup analysis (Section 4.3) reinforces the idea that experience builds readiness; organisations that overcome the initial hurdle of adoption display a significantly higher readiness profile, underscoring the necessity of structured intervention to help non-users cross that initial threshold.

4.5. Implementation framework for BIM adoption

The findings of this study were used to develop a framework (Figure 1) that provides a practical roadmap for enhancing FMO readiness in South Africa and supporting the systematic adoption of BIM. The framework is based on four categories of drivers identified in the empirical analysis: technology-related, process-related, personnel-related, and management-related factors. These drivers were consolidated into a

Table 5: TRI Values by category

Variable	TRI Value (Sum of categories)	Rank
Optimism	0.98	1
Innovativeness	0.83	2
Insecurity	0.70	3
Discomfort	0.66	4
Total TRI Score	**3.17**	

Authors' field data (2024)

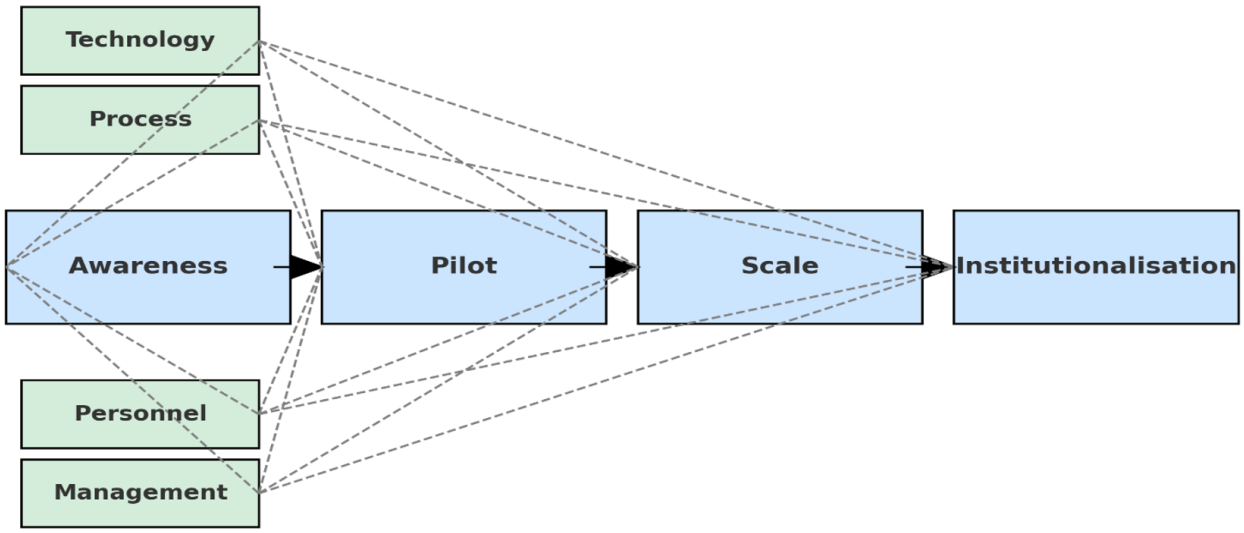

Figure 1: Phased framework for enhancing the readiness of facilities management organisations for BIM adoption in South Africa

phased roadmap consisting of four stages: awareness, pilot, scale, and institutionalisation.

The framework is specifically designed to address the four TRI dimensions. The initial stages focus on mitigating barriers: Awareness reduces Insecurity by establishing trust and data governance, while Pilot reduces Discomfort by providing controlled exposure to BIM tools and manageable complexity. The later stages build upon motivation: Scale and Institutionalisation enhance Optimism and Innovativeness by delivering measurable ROI and embedding continuous digital enhancement into the organisational culture.

The TRI analysis's empirical results directly inform the framework's phases. The high observed Insecurity (0.70) motivates Phase 1 (Awareness), which prioritises management-related drivers such as exposure to successful case studies and the development of owner data requirements to build stakeholder trust. Similarly, the documented Discomfort (0.66) directly underscores the need for Phase 2 (Pilot), which focuses on small-scale projects to demonstrate time-saving potential and strengthen trust in BIM processes, thereby reducing perceptions of complexity.

Conversely, the high scores in Optimism (0.98) and Innovativeness (0.83) drive the focus of the later stages. Phase 3 (Scale) leverages the existing organisational optimism to justify broader infrastructure upgrades and investment in structured training programs. At the same time, the high level of innovation provides the necessary motivation to integrate BIM outputs with existing maintenance systems. Finally, Phase 4 (Institutionalisation) relies on the sustained high optimism to embed continuous professional development and use BIM for strategic decision-making and life-cycle cost monitoring, ensuring the initial readiness is translated into long-term digital maturity.

Phase 1: Awareness

At this stage, the emphasis is on building trust, knowledge, and motivation among stakeholders. Technology-related drivers highlight BIM's potential for sustainable facility life cycles and its competitive advantage for early adopters. Process-related drivers include advocacy by professional bodies and government policy support through incentives or mandates. Personnel drivers at this stage involve awareness of the benefits of both early and late adoption. In contrast, management-related drivers include exposure to successful case studies and the articulation of client demand. Performance indicators include the number of awareness workshops conducted, the presence of an owner data requirement document, and the proportion of managers who can identify specific BIM benefits.

Phase 2: Pilot

Pilot: This stage involves small-scale implementation in a controlled environment, such as a selected facility or asset group. Technology-related drivers include the availability of trained personnel to manage digital models. Process-related drivers involve collaboration among professional bodies to establish guidelines for pilot projects. Personnel-related drivers emphasise using pilots to demonstrate time-saving potential, while management-related drivers focus on strengthening trust by showcasing measurable improvements in safety or maintenance. Indicators include the development of a BIM execution plan, the proportion

of pilot assets with verified digital records, and improvements in preventive maintenance compliance.

Phase 3: Scale
The scaling stage broadens BIM use across the organisation's projects. Technology-related drivers include upgrading infrastructure and integrating BIM with Computerised Maintenance Management Systems. Process-related drivers require government and professional bodies to standardise deliverables. Personnel-related drivers emphasise structured training programmes, while management-related drivers involve embedding specific BIM clauses into procurement contracts (to address the organisational readiness identified as crucial) and responding to growing client expectations. Indicators include the percentage of new projects with BIM deliverables, the number of staff trained to BIM proficiency, and integration of BIM outputs with maintenance systems.

Phase 4: Institutionalisation
At this stage, BIM becomes embedded in the organisation's culture and governance. Technology-related drivers emphasise continuous innovation and interoperability with other digital tools such as IoT and GIS. Process-related drivers include long-term policy enforcement and formalised standards. Personnel-related drivers focus on continuous professional development, while management-related drivers involve using BIM for strategic decision-making and life-cycle cost monitoring. Indicators include reductions in life-cycle costs, improvements in energy efficiency, and demonstrable return on investment. This phased framework strengthens the positive dimensions of readiness (Optimism and Innovativeness) while addressing the negative dimensions (Discomfort and Insecurity). By linking readiness drivers to implementation phases and measurable outcomes, the framework provides FMOs with a structured pathway to overcome barriers and realise the full benefits of BIM in facilities management.

5. Conclusion

This study examined the readiness of FMOs in South Africa to adopt BIM and developed a framework to guide systematic implementation. Using the TRI, the study identified a mixed level of preparedness characterised by high Optimism and Innovativeness but constrained by Discomfort and Insecurity. The overall TRI score of 3.17 indicates that while organisations recognise the value of BIM, they face practical and perceptual barriers that hinder full integration into operational workflows.

The study contributes to existing knowledge by combining diagnostic assessment with prescriptive guidance. The proposed implementation framework translates the readiness findings into a structured roadmap comprising four progressive phases: Awareness, Pilot, Scale, and Institutionalisation. The framework connects technological, process, personnel, and management drivers to practical outcomes, enabling organisations to move from initial interest to sustained digital transformation. Its distinctive contribution lies in being one of the first BIM frameworks to systematically align prescriptive actions with the four psychological dimensions of the TRI, ensuring each phase addresses the empirical barriers (Discomfort/Insecurity) and leverages the empirical drivers (Optimism/Innovativeness) identified in the local FMO context.

The findings suggest that advancing BIM adoption requires coordinated strategies that address both human and organisational dimensions of readiness. Priority actions include investing in continuous training, leadership-driven change management, and creating enabling policies supported by professional bodies and government agencies. Evidence of successful pilot projects and increased client demand can further strengthen motivation for adoption. For policymakers, the study highlights the need to establish clear BIM standards and regulatory frameworks that promote consistency across the facilities management sector. For practitioners, it underscores the value of collaboration, peer learning, and incremental adoption supported by demonstrable performance improvements.

It is important to acknowledge the methodological limitations influencing the scope of inference: this research relied on a non-probability convenience sample, featured a modest sample size (N = 51), focused solely on a single country (South Africa), and utilised self-reported data on readiness. Consequently, the generalisation of these quantitative results should be approached with appropriate caution. By linking readiness assessment with a practical implementation roadmap, this study provides a holistic contribution to both theory and practice. It enables FMOs in South Africa to move confidently from awareness of BIM to its institutionalisation as a core element of asset and service management.

6. Practical implications

The findings of this study have practical implications for FMOs, policymakers, and professional bodies in

South Africa. First, the framework developed provides a practical roadmap for organisations to progress from awareness to full institutionalisation of BIM. Facilities management leaders can use it to assess their current level of readiness and identify the specific interventions required at each phase of adoption.

Second, the results highlight the importance of continuous professional development and definite

training in addressing discomfort and insecurity toward digital technologies. Investment in technical capacity building, coupled with leadership commitment to digital transformation, will accelerate the integration of BIM into operational processes.

Third, policymakers and regulatory agencies have a critical role to play in institutionalising BIM by establishing mandatory standards, structured incentives, and procurement requirements that recognise BIM deliverables as part of facility management contracts. Such policy mechanisms can create a more enabling environment and promote industry-wide consistency.

Finally, professional associations should strengthen collaboration among members through workshops, shared digital platforms, and industry–academic partnerships that facilitate knowledge transfer. By implementing these practical measures, FMOs in South Africa can achieve greater technological maturity, improve asset performance, and position themselves competitively in the evolving digital built environment.

7. Limitations and Future Research

A critical limitation of this study lies in its scope: while it uses empirical data to inform the implementation framework, the framework itself remains qualitative and conceptual. Its efficacy, scalability, and practical utility were not empirically tested through implementation but instead validated via expert content review. Future research is therefore strongly emphasised to validate the framework's stages, tools, and outcomes in a live organisational setting over a defined period.

Future research could also focus on validating the proposed framework through longitudinal studies and pilot implementations within real organisational contexts. Comparative research across other developing economies would offer insights into the contextual differences that influence readiness and adoption pathways. Further statistical analyses could also examine causal relationships between readiness dimensions and adoption outcomes, while qualitative investigations could enrich understanding of behavioural and cultural factors that underpin digital transformation.

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Appendix 1

Table 3: TRI values per item

TRI Values
Optimism
BIM contributes to a better quality of life. $$OPT\ 1 = \frac{202}{51} \times 6.25\% = 0.25$$
BIM has the potential to give me more freedom of mobility $$OPT\ 2 = \frac{204}{51} \times 6.25\% = 0.25$$
BIM gives people more control over their daily lives $$OPT\ 3 = \frac{202}{51} \times 6.25\% = 0.25$$
BIM technology makes me more productive in my personal life $$OPT\ 4 = \frac{186}{51} \times 6.25\% = 0.23$$
Innovativeness
Other people come to me for advice on new technologies such as BIM. $$INN\ 1 = \frac{171}{51} \times 6.25\% = 0.21$$
In general, I was among the first in my circle of friends to acquire BIM technology when it was available. $$INN\ 2 = \frac{164}{51} \times 6.25\% = 0.20$$
I can usually figure out new high-tech BIM products and services without help from others. $$INN\ 3 = \frac{177}{51} \times 6.25\% = 0.22$$
I keep up with the latest technological developments in the field of BIM. $$INN\ 4 = \frac{186}{51} \times 6.25\% = 0.20$$
Discomfort
When I get technical support from a provider of a high-tech product such as BIM, I sometimes feel as if I am being taken advantage of by someone who knows more than I do. $$DIS\ 1 = \frac{127}{51} \times 6.25\% = 0.16$$
Technical support lines for BIM are not helpful because they explain things using excessive jargon and technical terminology. $$DIS\ 2 = \frac{138}{51} \times 6.25\% = 0.17$$
Sometimes, I think that technology systems are not designed for use by ordinary people. $$DIS\ 3 = \frac{130}{51} \times 6.25\% = 0.16$$
There is no such thing as a manual for a high-tech product or service that's written in plain language. $$DIS\ 4 = \frac{140}{51} \times 6.25\% = 0.17$$
Insecurity
People are too dependent on technology, such as BIM, to do things for them. $$INS\ 1 = \frac{136}{51} \times 6.25\% = 0.17$$
Too much BIM technology distracts people to a point that is harmful. $$INS\ 2 = \frac{112}{51} \times 6.25\% = 0.14$$
BIM lowers the quality of relationships by reducing personal interaction. $$INS\ 3 = \frac{118}{51} \times 6.25\% = 0.14$$
Whenever a technology gets automated, e.g. BIM, you need to check carefully that the system is not making mistakes. $$INS\ 4 = \frac{200}{51} \times 6.25\% = 0.25$$

Authors' field data (2024)

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The Effectiveness of Supply Chain Management in Enhancing Project Management Outcomes

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Abstract

Supply Chain Management (SCM) plays a critical role in improving the efficiency and effectiveness of project management across various industries. This paper explores the effectiveness of SCM on project management outcomes in local municipalities, focusing on key performance indicators such as cost reduction, time management, risk mitigation, and quality control. Effective SCM integration within project management frameworks minimizes delays, optimizes resource allocation, and improves overall project performance. This paper also examines case studies where efficient SCM has led to successful project completion and identifies challenges such as supply chain disruptions, vendor management issues, and compliance risks. The study employed a quantitative research design, targeting all professionals engaged in project management and supply chain management within the Thembisile Hani Local Municipality. Data collection considered factors such as organizational size, geographic location, and historical project performance. A stratified random sampling technique was used to ensure proportional representation across various professional categories, resulting in a sample of 56 participants for statistical analysis. Descriptive statistics, including frequencies and percentages, were used to summarize the data, while inferential analysis was conducted using Spearman's correlation to examine significant relationships between the constructs measured. The findings suggest that companies that prioritize robust SCM practices achieve better project outcomes in terms of cost efficiency, quality assurance, and stakeholder satisfaction. Additionally, integrating SCM principles into project management enhances operational efficiency and resilience, making it a vital component for achieving strategic project goals. The research highlights how the SCM strategies, such as just-in-time (JIT) delivery, and risk mitigation contribute to enhanced project execution. By streamlining supply chain processes, organizations can mitigate uncertainties, minimize waste, and improve collaboration among stakeholders. Future research should explore advanced digital technologies and sustainable SCM practices to further optimize project success.

Keywords: supply chain management, project management, key performance indicators, resource allocation, quality.

1. Introduction

Infrastructure development projects in local municipalities face multiple challenges, ranging from insufficient funds, budget constraints, political interference, maladministration and poor governance (Durdyev and Hosseini 2020). Latent conditions impede the municipality's ability to deliver projects effectively. The reasons for delays in public sector project delivery, according to the assessment of Thusi and Selepe (2023), there are labor shortages, unqualified workers, owner delays in evaluating and approving design papers, and project owner delays in progress payments. Nee, Beatrice and Yong (2022) reviewed the construction time performance of Malaysian public projects. Rather than project characteristics, the study discovered that delays are caused by variables related to excusable delays. With the use of factor analysis, Mahajan and Narkhede (2024) investigated the reasons for delays in construction projects and discovered poor site management, scope revisions, late payments to suppliers and contractors, and inadequate project planning. Gurgun, Koc and Kunkcu (2024) found that poor site management, inadequate planning, and a lack of materials were hindrances that deterred attaining

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effective project management delivery. The study aims to explore the effectiveness of the integration between supply chain and project management. With a focus on how effective resource allocation, supplier management, procurement, and logistics all contribute to project success, this study explores the integration of SCM practices within project management frameworks, emphasizing how efficient procurement, logistics, supplier management, and resource allocation contribute to the success of projects. Key findings from the research reveal that Thaba Chweu Local Municipality (THLM) lacks effective supply chain management procedures. The study's findings indicate that late payments to contractors and suppliers are the most significant cause that instigates project delays.

1.1. Research Problem

Despite the growing recognition of supply chain management (SCM) as a strategic tool for improving project performance, numerous organizations continue to experience cost overruns, schedule delays, resource shortages, and quality defects in project delivery. While SCM practices such as supplier integration, inventory control, logistics coordination, and information sharing are believed to enhance project outcomes, there is limited empirical evidence on how effectively these practices are implemented within project environments. Additionally, the dynamic and complex nature of modern projects, particularly those involving multiple stakeholders and geographically dispersed resources, increases the risk of supply chain disruptions, which can significantly undermine project success. As a result, it remains unclear to what extent effective supply chain management contributes to improved project management outcomes, and what specific SCM components most strongly influence measures such as timeliness, cost efficiency, quality performance, and risk mitigation. This gap in knowledge creates a need to investigate the effectiveness of SCM in enhancing overall project management performance across various industries.

1.2. Hypothesis

H_0 (Null Hypothesis):

There is no significant relationship between supply chain management effectiveness and project management outcomes.

H_1 (Alternative Hypothesis):

There is a significant positive relationship between supply chain management effectiveness and project management outcomes.

1.3. Research Question

To what extent does the effectiveness of supply chain management enhance project management outcomes in project-based organizations?

2. Literature Review

2.1. Background

From a corporate point of view, successful Project management is described by achieving a continuous stream of project objectives with consideration of time, cost, and quality at a desired performance level, while deploying resources efficiently and effectively, providing value to stakeholders (Kerzner, 2025). In the field of project management, Chen (2023) asserts that the supply chain is essential to the project's successful completion. A project's cost, schedule, and quality results can all be greatly impacted by how well its supply chain works. In implementing service delivery across the nation, municipalities are essential. According to Widjaja (2024), infrastructure projects are known to stimulate economic growth and social well-being. The Local Government: Municipal System Act 32 of 2000 mandates municipalities with the implementation of service delivery and developmental projects to improve the quality of life of residents and contribute to economic development (Mbedzi 2023). Nevertheless, implementing such projects does not come without challenges. It is against this backdrop that measures are sought to streamline operations to deliver quality output.

2.2. Supply Chain Management Challenges in Local Municipalities

In South African local municipalities, supply chain management (SCM) faces many obstacles that affect governance, financial efficiency, and service delivery. Sibanda, Zindi and Maramura (2020) pointed out several challenges in local municipalities, which include insufficient planning and forecasting, bureaucratic and inefficient processes, fraud and corruption. Other constraints highlighted by Maramura and Ruwanika (2023) are suppliers' challenges, poor governance and budget restraints, the effect of which often leads to the inability to meet developmental goals and compromised service delivery. The administration and completion of projects in the public sector, especially in municipalities, are fraught with difficulties (Barbier and Tengeh 2022). Among other things, the legal framework, political limitations, transparency concerns, and particular risk variables all have an impact on the project environment (Khodadad-Saryazdi 2023). Communities frequently express dissatisfaction with municipal projects, noting that many initiatives either fail to reach completion or do not deliver the intended outcomes. In numerous cases, projects are either indefinitely delayed or prematurely abandoned (Faku and Lukman 2025; Mamokhere 2025). These challenges are further compounded by inadequate project-management capacity, a shortage of qualified project managers, and insufficient monitoring mechanisms (Mnembe 2022). Vandersmissen and George (2024) regard planning in public sector organisations such as municipalities as more difficult because politicians usually have short-term

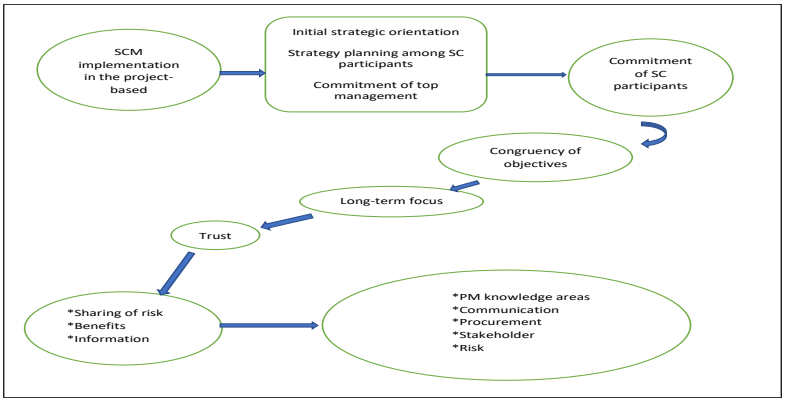
considerations, mainly because of the political cycle that is significantly shorter than the typical strategic planning cycle. In addition, politicians tend to reach for the low-hanging fruit to pacify constituents. This can result in the eluding of project governance as well as the polarization of policies that are in place.

2.3. Project Management Challenges in Local Municipalities

Project management in local municipalities in South Africa faces several unique challenges due to socio-economic, political, and operational factors. Notable key challenges encountered are a shortage of skilled personnel, political interference, corruption and mismanagement of funds, legislative and regulatory bottlenecks, and poor monitoring and evaluation (Munzhedzi and Phago 2020; Van der Waldt and Fourie 2022). One of the crippling challenges in project management is corruption and mismanagement. Mismanagement of funds, irregular procurement processes and tender fraud are rampant in several municipalities. Irregular expenditure in South African municipalities has been massive: at the end of the 2021/22 financial year, municipalities had a closing irregular-expenditure balance of c. R30.99 billion (Auditor-General of South Africa 2022). The misappropriation of funds leads to a negative impact on service delivery in that projects are abandoned or left incomplete. Budget constraints - Municipalities frequently encounter restricted budgets, which are further exacerbated by their dependence on national grants and irregular revenue collection. Legislative and regulatory bottlenecks - bureaucratic red tape and compliance with complex regulatory frameworks slow down project approvals and stall execution. These bottlenecks lead to cost escalations and delayed service delivery. Poor monitoring and evaluation - projects fail because of poor or inadequate monitoring systems that track and evaluate outcomes, leading to a lack of accountability and failure to identify areas warranting improvement.

2.4. Mitigating factors to enhance SCM effectiveness in Project Management

It is often known that supply chain management (SCM) and project management (PM) are closely related fields that, when properly coordinated, can greatly improve organizational effectiveness and produce superior results. Common features in both fields include planning, execution, monitoring, and controlling processes to achieve specific objectives (Tang 2021). Whereas SCM focuses on the flow of goods, information, and resources across a network to meet customer demand, PM is primarily concerned with the execution of temporary, goal-specific initiatives within defined constraints of time, cost, and scope. To maximize the contribution of the two disciplines, there should be careful planning and effective utilization of resources to optimize performance (Elisa, Nabella and Sari 2022). Both SCM and PM accentuate strategic planning and effective utilization of resources. The integration of SCM into PM enhances resource allocation, visibility and control. Consequently, linking supply chain management and project management is essential for operational synergy. It is widely accepted that this integration enhances efficiency, mitigates risks, supports innovation, and ultimately ensures successful project delivery in competitive and dynamic business environments. Strategic advantage can be achieved significantly by organizations that invest in bridging these two domains. The built industry, encompassing sectors like construction, architecture, engineering, and urban planning, is a cornerstone of economic development and societal progress. It involves the design, construction, and maintenance of infrastructure such as buildings, roads, bridges, and public spaces. The industry is highly dynamic, influenced by factors such as technological advancements, economic conditions, environmental sustainability, regulatory frameworks, and evolving customer needs. Diagram 1 below illustrates the Supply chain-project management value chain.



Source: Wei, Prybutok and Sauser (2021)

Diagram 1: Implementation of SCM and Contribution to the PM Body of Knowledge

The integration of SCM into PM enhances resource allocation, visibility and control. It is strongly suggested that there be an effective collaboration between supply chain managers and project managers to ensure that project schedules are synchronized with supply chain lead times. Concerning risk management, PM and SCM are both essential. Project timelines may be at risk due to supply chain disruptions such as supplier breakdowns or delays in procurement. Furthermore, innovation, particularly in areas such as just-in-time inventory, modular construction, and lean project management, is driven by the collaborative efforts between PM and SCM. Consequently, linking supply chain management and project management is essential for operational synergy. It is widely accepted that this integration enhances efficiency, mitigates risks, supports innovation, and ultimately ensures successful project delivery in competitive and dynamic business environments. Strategic advantage can be achieved significantly by organizations that invest in bridging these two domains. The built industry, encompassing sectors like construction, architecture, engineering, and urban planning, is a cornerstone of economic development and societal progress. It involves the design, construction, and maintenance of infrastructure such as buildings, roads, bridges, and public spaces. The industry is highly dynamic, influenced by factors such as technological advancements, economic conditions, environmental sustainability, regulatory frameworks, and evolving customer needs. The industry is shaped by various aspects such as:

***Advancement in technology*:** Innovations such as Building Information Modeling (BIM), prefabrication, and automation are revolutionizing design and construction processes, enhancing efficiency, precision, and collaboration across stakeholders.

***Green Building**:* The growing demand for sustainable and energy-efficient buildings has led to the adoption of eco-friendly materials and renewable energy systems. This shift is primarily driven by both environmental concerns and regulatory requirements aimed at reducing the carbon footprint of construction projects.

Economic factors: Global economic instability, fluctuations in interest rates, and material costs directly impact the built industry. Thriving economies do stimulate growth in construction projects, while downturns often lead to reduced demand and tighter project budgets.

3. Research Methodology

This paper adopted a quantitative method approach. This study adopts a positivist research philosophy, which is grounded in the belief that reality is objective, measurable, and independent of human perception. Positivism assumes that social phenomena, such as supply chain management practices and project management outcomes, can be observed, quantified, and analysed using statistical techniques (Park, Konge & Artino, 2020). In the context of this study, the positivist stance enables the researcher to systematically examine the relationship between supply chain management effectiveness and project management performance using empirical data rather than subjective interpretations. Under this philosophy, the study relies on structured, numerical data collected from project-based organisations to test predetermined hypotheses about how specific supply chain management elements, such as supplier integration, logistics efficiency, information sharing, and inventory control, influence project outcomes, including cost, time, quality, and risk performance. The researcher maintains objectivity throughout the process, using standardized instruments such as questionnaires to minimise bias and ensure consistency across respondents.

The quantitative approach also supports the use of statistical analysis, such as correlation and regression techniques, to identify the strength and significance of relationships between variables. By adopting a positivist quantitative philosophy, the study aims to generate generalizable findings that can be applied across different project environments. This philosophical stance, therefore, ensures that the research produces reliable, replicable, and evidence-based insights into the effectiveness of supply chain management in enhancing project management outcomes.

3.1. Population and Sample

The population of interest comprises all professionals within the Thembisile Hani Local Municipality involved in project management and supply chain management. This includes, but is not limited to, project managers, procurement officers, finance officials, senior management, and other relevant stakeholders. Primary data was collected from a sample of 56 participants within the district.

3.2. Sample strategy

The paper adopted a stratified random sampling technique within each selected municipality to ensure proportional representation of different professional categories. A sufficient sample size was determined using a power analysis to ensure adequate statistical power for detecting significant relationships. This ensured the inclusion of individuals with diverse perspectives and in-depth knowledge. The sample size was guided by data saturation until no new significant information emerged.

3.3. Data Collection Instruments

For quantitative methodology, a structured questionnaire was developed based on a thorough

review of the literature on SCM and project management effectiveness. The questionnaire included key elements such as demographic information, Project performance, SCM implementation and overall project success. A (1-5) Likert scale was utilized to measure outcomes.

The questionnaire was pilot tested with a small group of professionals to ensure clarity, validity, and ease of completion before final distribution. The questionnaire was administered online using Google Forms to facilitate data collection and analysis. The interview guide included open-ended questions designed to explore the following:

I. Perceptions of the role of SCM in project management;

II. Challenges and barriers to effective SCM implementation in the municipality;

III. Examples of successful and unsuccessful projects and the role of SCM in their outcomes;

IV. Suggestions for improving SCM practices to enhance project management outcomes, and

V. Impact of SCM on specific project aspects such as time, cost, quality, and stakeholder satisfaction.

With the help of current technology, interviews were conducted via video conferencing, considering logistical considerations. All interviews were audio-recorded with the participant's prior consent and transcribed verbatim for analysis.

3.4. Data Analysis Techniques

Quantitative data were examined using the Statistical Package for the Social Sciences (SPSS) version 30.0. The analysis in this study primarily employed both descriptive and inferential statistics. Demographic data were summarized using frequencies and percentages.

Reliability of the items within each construct was assessed using Cronbach's alpha coefficient. Spearman's correlation analysis was then conducted to examine significant relationships between the measured constructs.

4. Findings and Discussion

Results from the study reveal that THLM lacks effective supply chain management procedures. Key findings from the research reveal that SCM significantly impacts time, project cost, schedule, and quality.

The study's findings indicated that late payments to contractors and suppliers were the most significant cause of instigating project delays. There is a need for effective collaboration between SCM and PM teams for success.

The main reason for project delivery delays, according to Shivambu and Thwala (2019), is suppliers' late payments. These results are consistent with those of a study on Kenyan local administrations (Barsemoi, Mwangagi and Asienyo 2014).

In the context of South African municipalities, a lack of sufficient supply chain skills and capabilities has also been identified as a key factor undermining service delivery (Ambe 2016). Together, these studies underscore the critical role of effective supply chain management and timely procurement practices in ensuring successful project implementation and public service delivery across different African contexts.

Another significant discovery is that ineffective execution of some management tasks and responsibilities causes project completion delays, which impacts the municipality's ability to provide services.

Findings reveal a greater need for technological improvements in the current systems to streamline supply chain processes and improve project success. The public sector in its current form faces a unique challenge in implementing SCM and PM due to regulatory constraints and bureaucratic processes.

Results point to the municipality's capacity to complete projects on schedule due to critical factors, such as clear scope definition, effective communication, employee training, investing in emerging technology, allocating sufficient resources, and a work plan.

4.1. Descriptive Statistics of the Respondents

Table 1 displays the descriptive statistics of the study participants. Over half (66.1%) of the participants were women, while 33.9% were men. Many participants were general workers (35.7%), followed by supervisors (16.1%), artisans (17.9%), technicians (16.1%), and others (14.2%). Regarding educational qualifications, 48.2% of participants held a certificate as their highest level of education, 32.1% had a diploma, 16.1% had a degree, and just 3.6% had a master's degree.

Additionally, the study found that 26.8% of participants had less than six years of work experience, 33.9% had 6 to 10 years, and 39.3% had 11 to 15 years of experience.

Table 1: Descriptive statistics of the respondents (n = 56)

Variable	Categories	Frequency	Percentage (%)
Gender	Male	19	33.9%
	Female	37	66.1%
Total		**56**	**100**
Job title	General workers	20	35.7%
	Supervisors	9	16.1%
	Artisans	10	17.9%
	Technicians	9	16.1%
	Other	8	14.2 %
Total		**56**	**100**
Academic qualification	Certificate	27	48.2%
	Diploma	18	32.1%
	Degree	9	16.1%
	Masters	2	3.6%
	PhD	-	-
Total		**56**	**100**
Length of service (years)	1 - 5	15	26.8%
	6 - 10	19	33.9%
	11 - 15	22	39.3%
	16+	-	-
Total		**56**	**100**

Source: Author's construction

4.2. Descriptive Statistics about the Supply Chain Management Procurement Strategies

4.2.1. Deliberate practices that delay project delivery in THLM

The degree to which respondents agree or disagree with the idea that THLM uses strategies to implement the MFMA Act of 2003 despite intentional activities that cause the municipality's project delivery to be delayed is shown in Table 2. A Likert scale with a range of 1 (strongly disagree) to 5 (strongly agree) and a mean score (MS) between 1.00 and 5.00 was used to measure the responses. Table 2 shows that respondents agreed that deliberate practices such as late payment of contractors and suppliers contribute to project delivery delays in THLM (MS > 3.40 to ≤ 4.20). Additionally, the respondents strongly disagree (MS > 1.80 to ≤ 2.60) that workers are competent in project delivery and possess sufficient supply chain management skills. 80% of the variables ranked 1 to 4 have an MS ranging > 1.80 ≤ 3.40, which indicates that the respondents strongly disagree with the following, namely that THLM complies with the MFMA of 2003 in implementing projects, THLM has effective supply chain management practices, payments to suppliers are made within 30 days, and employees have adequate supply chain management skills and competences.

4.2.2. Impact of late payments on project delivery

The MS for all the variables, specifically 100%, fall within the range (MS > 3.40 to 4.20), as can be shown in Table 3. This indicates that every respondent concurs that late payments have the following effects on project completion: they cause workers to go on strike (MS =

Table 2: Deliberate practices that delay project delivery in THLM

Contributor	Response (%) Strongly disagree……Strongly agree					MS	Rank
	1	**2**	**3**	**4**	**5**		
Late payments to contractors and suppliers contribute to project delays	0.0	12.5	0.0	44.6	42.9	3.95	1
THLM complies with the MFMA of 2003 in implementing projects	8.9	16.1	23.2	23.2	28.6	3.38	2
THLM has an effective supply chain management practices	1.8	35.7	28.6	32.1	1.8	2.98	3
Payments to suppliers are made within 30 days	1.8	39.3	28.6	28.6	1.8	2.92	4
Employees have an adequate supply chain management skills and competencies	35.7	33.9	17.9	10.7	1.8	2.28	5

Source: Author's construction

Table 3: Impact of late payments on project delivery

Outcome	Response (%) Strongly disagree……. Strongly agree					MS	Rank
	1	**2**	**3**	**4**	**5**		
Workers strike on project site	0.0	0.0	14.3	39.3	46.4	4.07	1
The construction programme is prolonged	0.0	0.0	16.7	42.9	41.1	4.01	2
Skilled employees leave the project	5.4	3.6	12.5	46.4	32.1	3.78	3
Projects experience cost and time overruns	3.6	3.6	14.3	44.6	33.9	3.82	4
Contractor runs out of working capital (cash flow problems)	0.0	12.5	23.2	32.1	32.1	3.68	5

Source: Author's construction

4.07), extend the construction schedule (MS = 4.01), and cause expert personnel to depart the Project (MS = 3.78), leads to time and expense overruns (MS = 3.82) and causes the contractor to run out of working capital (causing cash flow issues) (MS = 3.68).

4.2.3. Measures for improving the performance of the supply chain management unit

Table 4 shows that 75% of the variables ranked 1–3 on measures for enhancing supply chain management unit performance to improve project delivery in THLM had MS values in the range > 3.40 ≤ 4.20. This suggests that most respondents believe that the following actions can improve THLM project delivery: adding more staff members (MS = 3.77), training the current staff members (MS = 3.88), and implementing the newest and most effective supply chain management procurement system (MS = 3.58). In contrast, 25% of the variables (ranked 4) have an MS that falls between >2.60 and ≤ 3.40. This indicates that the respondents were either indifferent to or disagreed with the concept that project delivery in THLM can be improved by using current employees in conjunction with improved planning and communication capabilities.

4.2.4. Management practices that delay project delivery in THLM.

The respondents' level of agreement or disagreement with management approaches that could defer project delivery in THLM is shown in Table 5. The responses were scored using a mean score (MS) that ranged from 1.00 to 5.00 and a Likert scale that went from 1

Table 4: Impact of late payments on project delivery

Measures/action	Response (%) Strongly disagree…….Strongly agree					MS	Rank
	1	**2**	**3**	**4**	**5**		
Propose training of the existing staff members	0.0	7.1	16.1	37.5	39.3	3.88	1
Increase the number of staff members	0.0	10.7	17.9	37.5	33.9	3.77	2
Introducing the latest most and efficient supply chain management procurement system	0.0	10.7	30.4	35.7	23.2	3.58	3
Utilise the existing staff members but strengthen proper planning and communication	12.5	30.4	17.9	35.7	3.6	2.91	4

Source: Author's construction

Table 5: Management practices that delay project delivery in THLM

Contributor	Response (%) Strongly disagree……Strongly agree					MS	Rank
	1	**2**	**3**	**4**	**5**		
Late approvals contribute to project delays	0.0	3.6	14.3	44.6	37.5	3.94	1
Late payments are made to contractors and suppliers	1.8	1.8	17.9	41.1	37.5	3.90	2
Senior management is always available when required	21.4	25.0	32.1	12.5	8.9	2.71	3
Changes in scope are approved within a reasonable time frame	33.9	30.4	21.4	7.1	7.1	2.39	4
Projects are approved within a reasonable time frame	39.3	39.3	19.6	1.8	0.0	2.08	5

Source: Author's construction

(strongly disagree) to 5 (strongly agree). Forty percent of the variables (ranked 1 and 2) have an MS between > 3.40 and ≤ 4.20, according to Table 5. According to this, the respondents concur that the following management practices cause project delivery delays at THLM: late approvals (MS = 3.94) and late payments to suppliers and contractors (MS = 3.90). The respondents also expressed either neutral disagreement (MS = 2.71) or disagreement that senior management is always available when needed, which causes THLM project delivery to be delayed. In addition, 40 percent of the variables (ranked 4 and 5) have MS values between > 1.80 and ≤ 2.60. This suggests that respondents disagree that senior management follows the following procedures to enhance project delivery: projects are approved within suitable time frames (MS = 2.08) and revisions to the project scope are approved within reasonable time limits (MS = 2.39).

4.2.5. Reliability Statistics

To assess the reliability of the items, the researchers employed Cronbach's alpha coefficient (α). Reliability refers to the internal consistency of the construct(s) and their stability (Nunnally & Bernstein, 1994). The Cronbach's alpha value ranges from 0 to 1, and according to Bagozzi and Yi (1998), an α value greater than 0.6 indicates data consistency and reliability for analysis. In this study, the value of α was greater than 0.7 in each section, indicating that all the items agreed with each other (Table 6).

4.2.6. Spearman correlation analysis

The Spearman correlation analysis revealed significant positive relationships among the factors contributing to project delivery delays in the Thembisile Hani Local Municipality (THLM). There is a strong positive correlation (r = 0.65, p-value = 0.001) between deliberate practices that delay project delivery and management practices that contribute to delays, indicating that inefficient management often coincides with intentional behaviors that impede project progress. A moderate positive correlation (r = 0.50, p-value = 0.012) was observed between deliberate delaying practices and the impact of late payments, suggesting that projects affected by deliberate delays are also more likely to experience financial-related disruptions. Furthermore, management practices that delay project delivery are strongly associated with the impact of late payments (r = 0.70, p-value < 0.001), demonstrating that poor management exacerbates the negative effects of financial delays on project completion. Overall, these results highlight that project delays in THLM are multifaceted and interrelated, with management inefficiencies, deliberate behaviors, and late payments collectively contributing to challenges in timely project delivery.

5. Discussion

This section discusses the findings from the information gathered from respondents regarding the influence of SCM on project management results in Thembisile Hani Local Municipality. Assuring the timely procurement and receipt of all project inputs is the goal of an effective and efficient supply chain management, which helps to prevent delays in project completion. Nonetheless, the key data results mostly show that THLM lacks effective supply chain management procedures. Many respondents said that the MFMA Act of 2003 is not being implemented correctly, according to the results of the question that aimed to determine the extent to which THLM employs strategies.

The study's findings indicated that late payments to contractors and suppliers were the most significant cause of instigating project delays. Project execution in THLM is impacted by late payments in numerous ways. These include the depletion of working capital by contractors, strikes by workers on building sites, an extended construction schedule, a high rate of skilled personnel turnover, and time and cost overruns. Skills in supply chain management and adherence to the MFMA were the least ranked variables in this study. The top reason for project delivery delays, according to Shivambu and Thwala's (2019) study, is suppliers' late payments. These results are consistent with those of a study on Kenyan local administrations (Barsemoi, Mwangagi and Asienyo 2014). The authors discovered that the least common reason for delays in supply chain management was a lack of capabilities. The authors discovered that the least common reason for delays in supply chain management was a lack of skills.

The findings also show that many respondents did not

Table 6: Spearman correlation analysis

Analysis	Spearman's rho correction (r)	p-value
Deliberate practices that delay project delivery in THLM - Management practices that delay project delivery in THLM	0.65	0.001
Deliberate practices that delay project delivery in THLM - Impact of late payments on project delivery	0.50	0.012
Management practices that delay project delivery in THLM - Impact of late payments on project delivery	0.70	<0.001

Source: Author's construction

agree with the claim that workers possess sufficient supply chain management competencies, knowledge, and abilities. The poor performance of procurement departments can largely be attributed to incompetent staff. The study of Hoque (2022) establishes that one of the main issues affecting service delivery in South African municipalities is the lack of necessary supply chain skills and capabilities. Another significant discovery is that ineffective execution of some management tasks and responsibilities causes project completion delays, which impacts the municipality's ability to provide services. The municipality's senior managers' availability is one such issue. Project delays would result from the lack of timely approval of documentation, including payment certificates, way leaves, overtime drawings, and variation orders. Apart from the absence of management, one of the management issues that contributed to project delivery delays in THLM was the client's delayed document approval. Most respondents stated that delays are mostly caused by the client's delayed approval of papers. Numerous researchers agree with these conclusions. The time it takes to get a new customer or consultant approval could cause the building project to be delayed.

The responders also pointed out a crucial finding that indicates organisational practices are a significant contributor to project delivery delays. According to the respondents, the municipality's capacity to complete projects on schedule can be influenced by critical factors, such as clear scope definition, effective communication, employee training, investing in emerging technology, allocating sufficient resources, and properly planning work activities. The respondents felt that the municipality's feedback system was insufficient. Therefore, poor organisational practices could defer the completion of a project.

6. Conclusion and further research

Evidence from this study has revealed that several obstacles cause the THLM organization project delivery to be delayed. Problems with supply chain and procurement management are one example of such a dilemma. The analysis discovered that certain organisational practices are to blame for the project delivery delays. When employees lack the necessary skills or knowledge of the supply chain and other organisational processes, management and project implementation become inefficient, which delays project completion. It was also discovered that late supplier payments impeded project progress and resulted in time and expense overruns. According to the findings, the municipality typically takes a long time to approve projects, process project documentation, and process payments, which causes delays in project delivery. Political meddling or management's inability to approve documents are the usual causes of delays. Politicians are sometimes unwilling to accept the proposals of planners, as such proposals will not further their political interests. As a result, projects take a long time to complete due to permission delays. During the implementation phase, projects typically undergo scope modifications, which cause delays in project completion. The community may occasionally cause changes in scope, which can cause worries and necessitate some project additions. Additionally, it takes a long time for scope adjustments to be accepted, and during that time, project activity would have been put on hold to accommodate the changes. As a result, scope adjustments lead projects to take longer to finish. Organisational procedures were found to negatively affect the efficient completion of projects. Planning, communication, staff training, and hiring and choosing staff are a few of these. Ineffective implementation of these organisational procedures has a detrimental impact on project management. Consequently, inadequate planning, poor communication, a lack of training, and the hiring of inexperienced or under-qualified staff are frequently the reasons behind project completion delays.

Considering the findings of the study, the following recommendations and possible directions for further research were developed. Enhancing employees' abilities is essential for THLM management to ensure that they have the knowledge and abilities needed to carry out infrastructure projects successfully. Since the organisation is a system that interacts to create desired outcomes, the project management team should receive training on effective project management, and the remaining staff members should be adequately knowledgeable in their respective roles. Additionally, the municipality should encourage and foster an organisational culture of learning in which staff members participate in ongoing education through information sharing and training. To guarantee that every project has a precisely defined scope, it is advised that the project design stage be carried out completely. According to the study's findings, modifications to the project's scope cause delays in its completion since the contractor must halt work while awaiting clearance of the revisions. Increased project expenses could also result from scope adjustments. Therefore, before execution, the project design team should thoroughly investigate the project's requirements. To prevent scope modifications during project implementation, meaningful consultations should be held with both project sponsors and contractors.

Community consultations are also essential. Insufficient stakeholder participation can result in community interference during project execution and demands for scope expansions, both of which can severely affect the project's development. Thus, it is essential to make sure that all scope-related concerns are taken care of during the project design phase to prevent scope modifications later. Enhancing communication and project planning is essential for

THLM. Effective project planning guarantees the development of the right scope, timeline, and critical routes, all of which contribute to the project's seamless operation. To prevent poor budgeting, which can halt a project's development when resources run out, planning should also include a detailed study of the resources needed to complete the project. All stakeholders, including community representatives, should be involved in the planning process to ensure that all project requirements are met. For activities to be coordinated, there should be good communication throughout the project's lifecycle in addition to appropriate planning. To guarantee the efficient exchange of information, the municipality should set up efficient communication systems. This includes creating a feedback mechanism that will notify stakeholders about the project's progress and potential obstacles during implementation.

Enhancing the organization's supply chain and procurement management procedures is also recommended for management since they are essential to the accomplishment of project delivery. Supply chain management requires qualified personnel, allocating sufficient resources to the function, and automating all processes to guarantee effectiveness. Staff members involved in supply chain management should receive training on the MFMA 2003's provisions. Putting monitoring and accountability procedures into place to guarantee that transactions are completed quickly will help prevent delays in paying contractors and other suppliers. To gain a better understanding of municipal project management and the general issues that impact project delivery in the organisations, more research on the same subject can be done, concentrating on several municipalities in the province.

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