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Drivers for Implementing Supply Chain Management in Project Delivery: Construction Professionals Perspective

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Abstract
Supply chain management integration in construction project delivery emerged from demand to ensure effective planning, communication and coordination of resource flows and gain control over the various factors influencing project delivery and performance. Hence, this study assesses the drivers of implementing supply chain management in construction project delivery using the perspective of construction professionals in South Africa. Based on findings from the literature review, a structured questionnaire was developed, and respondents were selected using a simple random sample to obtain data from construction professionals in Durban, South Africa. Descriptive statistics and the Kruskal-Wallis test were conducted to determine construction professionals' perspectives on the identified drivers of implementing supply chain management in construction project delivery. According to the study's findings, the essential drivers of implementing supply chain management in construction project delivery in South Africa include reliable database of professional suppliers, availability of suppliers with knowledge of supply chain management, effective government regulations, automated logistic systems, efficient feedback systems for information, effective management of people and the environment, and stakeholders' knowledge of supply chain management. The study findings contribute to the body of knowledge as they unravel drivers to implement supply chain management in project delivery. It also forms solid empirical evidence for future studies and practical implications of fostering long-term relationships between firms and service providers, developing well-managed supply order cycles, and developing an effective database of suppliers with knowledge of supply chain management. The study recommends that the operations of firms, stakeholders, professional institutions, and government agencies in the construction industry be guided by drivers of supply chain management, including effective government regulations, integration of automated logistic systems, efficient feedback systems for information, and effective management of people and the environment.

Keywords
Construction professionals, Drivers, Project delivery, Supply chain management, South Africa.

1. Introduction
Various factors have often plagued construction project delivery due to the exchange of activities among stakeholders, the complexity of construction operations, and construction methods (Zhong et al., 2022). Spanning across several factors influencing project design, planning, procurement, construction, maintenance, and management (Ogunde et al., 2017; Akinola et al., 2019; Masoetsa et al., 2022**)**. O'Brien et al. (2009) and Ogundipe et al. (2018) noted that the lack of reliable site production systems, including inadequate and delayed information flow, material orders, material delivery and construction schedules, affected the project delivery. Nonetheless, there is criticism for the poor project delivery and performance in most construction project phases. Zhong et al. (2022) noted that a critical step towards successful project delivery is determined through methods that match the characteristics of a construction project. Zhong et al. (2022) posited that the continuous failure in construction projects calls for innovative ways to manage project delivery processes to keep up with technological and systems advancements. Integrating supply chain management (SCM) in project delivery would improve the effectiveness and efficiency of planning and control processes in procurement activities, operations, and logistic functions to alleviate delivery time issues, boost financial

performance, enhance customer satisfaction, and foster supplier trust (Rahman et al., 2017). Supply chain management allows the integration of technologically connected security and communication systems to manage parties and processes involved in construction delivery to give the customers the efficiency of quality and service operations (Nugroho et al., 2021).

According to Tiwari, Sheperd, and Pandey (2014) and Al-Werikat (2017), the supply chain provides a network of organisations collaborating to deliver products, goods or services to their end users. Supply chain (SC) in the construction sector often refers to the strategic management of operations, tasks, flow of information, and processes involving various independent organisational networks and interactive relationships in delivering value in project execution and performance (Benton & McHenry, 2010). Nugroho et al. (2021) describe SCM in construction projects as the operational flow and strategic cycle, including workers, materials, equipment, subcontracting, and project completion. Supply chain management plays a significant role in the construction market in strengthening materials procurement and production planning (Al-Werikat, 2017). Hence, integrating supply chain management (SCM) in project delivery emerged from the demand to strategically improve competitiveness, increase profits, and control the various factors and variables influencing construction project delivery and performance (Akinola et al., 2019). Nonetheless, the benefits and challenges influencing construction project delivery have been widely recognised and studied (Amade, 2016; Kikwasi et al., 2023). The drivers of implementing supply chain management in project delivery created knowledge gaps in the construction industry, particularly in South Africa. Hence, this study explores the perspective of construction professionals in the South African construction industry to assess drivers of implementing supply chain management in construction project delivery in South Africa. This will assist in bridging the knowledge gaps of supply chain management among construction stakeholders in project delivery

2. Literature Review

The construction industry operations are interconnected with activities of various sectors, including materials and equipment manufacturers, financial institutions, contracting and consulting firms, and compliance agencies, among others (Al-Werikat, 2017). Al-Werikat (2017) and Ogundipe et al. (2020) posited that supply chain management could become very complex in large projects because of the various materials requisition and stakeholder management (sub-contractors and suppliers) involved in the project delivery. However, effective supply chain management in construction project delivery provides strategies to mitigate bad construction design, ineffective schedule management, poor budget management, use of poor construction methods., inadequate human resource management, and lack of good team relationships (Meeamplol & Ogunlan, 2006; Ogunbayo et al., 2023). This requires understanding the drivers influencing supply chain management implementation in the construction project delivery. Saad (2018) noted that construction management is driven by the principles of the supply chain, in which successful project delivery maintains a balance between project management actions, project-related and human-related factors, and external factors (economy, specific project management models, and software).

Kwofie, Aigbavboa, and Matsane (2019) attributed the drivers of implementing a supply chain in construction project delivery to efficient stakeholders' collaborative support, efficient operational practices, and effective people and environmental management. The supply chain influences resource management and relationships between suppliers and end users through the processes and activities of construction project delivery from upstream to downstream (Tiwari et al., 2014; Nugroho et al., 2021). Fawcett et al. (2008) and Kwofie (2019) added that transparent information systems, cross-functional collaboration, and collaborative planning are performance improvement and innovation drivers of supply chain management. To this end, Doan (2020) highlighted the key drivers of effective supply chain management in construction project delivery, including effective quality of materials, manageable order cycles, enhanced delivery performance, asset management, increased cash-to-cash velocity, quality management systems, effective inventory procedure, automated logistic systems, and efficient information system. Emuze and Smallwood (2013) noted that the inherent drivers of SCM in project delivery include having a reliable database of professional suppliers, productivity measures of cost reporting, timely materials requisition and long-term relationships with service providers. The construction supply chain is not a chain of business-to-business relationships but a network of multiple organisations and relationships comprising the flow of information material, services or products and the flow of funds between the client, designers and suppliers (Amade et al., 2016). Cigolini et al. (2022) added that planning, decision-making, use of digital technologies, and upfront planning and procurement help to establish the conditions for the supply chain to function effectively in project delivery.

Handayani et al. (2019) admitted that implementing green practices in supply chain management could improve construction project delivery. However, Handayani et al. (2019) identified drivers that influence SCM in project delivery end-user demand, growing competition, stakeholders' knowledge of SCM, commitment to environmental sustainability, government regulations, and availability of suppliers with SCM knowledge. Furthermore, Attia et al. (2023) noted that the sustainability dynamic could drive supply chain management in construction project delivery.

Attia et al. (2023) identified quality assurance, data safety, collaboration, capability, economic paybacks, and risk management drivers for implementing supply chain in construction project delivery.

3. Research Methodology

This study uses construction professionals' perspectives to explore drivers for implementing supply chain management in construction project delivery. To begin with, extant literature was sought and reviewed to identify variables for designing a questionnaire survey for data collection. A quantitative research approach was adopted, using a multistage random sampling method. This research method eliminates the bias of sample clustering by breaking the population into various clusters based on professions from which a simple random sample can be attained from each cluster (Rea & Parker, 2014). This allows for a selection sample that evenly covers the entire element and ensures the respondents for this study were reached (Ogunbayo et al., 2023). A select representative construction professional in Durban, in KwaZulu-Natal province, South African construction industry, was considered for this study. The professionals were drawn from construction industry experts in Durban, KwaZulu-Natal province, South Africa, based on their involvement, knowledge, and experience in supply chain management and construction project delivery. Durban is in a coastal zone with attractive construction project investments. Durban has been rated a top-five quality-of-livable city in Africa and the Middle East by Mercer Consulting in 2015 and 2016, which has increased quality project delivery in the region. Hence, sixty-five (65) questionnaires were distributed to the selected respondents using a simple random sampling method, and 52 copies were retrieved from the respondents. A five-point Likert scale was adopted using Strongly Agree = 5, Agree = 4, Neutral = 3, Disagree = 2, and Strongly Disagree = 1. The data obtained was analysed using IBM SPSS version 28. Furthermore, the reliability of the data collection instrument was determined using Cronbach's alpha, a statistical measure of internal consistency. Cronbach's alpha returned a 0.941 value above the 0.6 recommended minimum value and indicated high consistency (Pallant, 2016). The data obtained was then analysed using descriptive analysis (percentage, frequency, mean score, and standard deviation) to rank respondents' perspectives on drivers for implementing supply chain management in construction project delivery. This was followed by the Kruskal-Wallis test, a non-parametric test used to determine the significant difference between two groups of respondents using a p-value at a 95% confidence level. The Kruskal-Wallis test compared respondents' perspectives based on their professional designations in construction project delivery. According to Yong (2013) and Pallant (2016), this test is a robust statistical method that enhances the validity of the research findings.

4. RESULTS

Table 1 presents the demographic information of the 52 professionals who participated in the study. The study findings show the highest academic qualification of the respondents: 51.9% had bachelor's degrees, 19.2% had honour's degree level, 15.4 % had master's degrees, 9.6% had matric certificates, 1.9% had a post-matric certificate, and 1.9% had Doctorate degrees. The designations of professionals in this study comprise 32.69% construction managers, 19.2% project managers, 17.3% quantity surveyors, 9.6% architects, 7.7% civil engineers, 5.8% town and regional planners, 3.85% electrical engineers, and 3.86% others. In addition, the respondents working experience indicates that 52% had 10-15 years of experience, 23% had 5-10 years of experience, 19.21% had 0-5 years of experience, and 5.76% had 16-20 years of experience.

Table 1: Respondents demographic information

Demographic information	Frequency	Percentage
Highest academic qualification		
Bachelor's degrees	27	51.9%
Honour's degree	10	19.2%
Master of Science degree	8	15.4%
Matric certificates	5	9.6%
Post matric certificates	1	1.9%
Doctor of Philosophy (Ph.D.)	1	1.9%
Total	52	100%
Designation		
Construction managers	17	32.69%
Project managers	10	19.2%
Quantity surveyors	9	17.3%
Architects	5	9.6%

Civil engineers	4	7.7%
Town and regional planners	3	5.8%
Electrical engineers	2	3.85%
Others	2	3.86%
Total	52	100%
Years of working experience		
10-15	27	51.92%
5–10	12	23%
0-5	10	19.21
16-20	3	5.76%
Total	52	100%

Additionally, Table 2 presents the ranking of the descriptive analysis using mean scores (MS) and standard deviation (SD) from identified drivers of implementing supply chain management in construction project delivery in the South African construction industry. The professionals' perspectives of the identified drivers of supply chain management in construction project delivery were based on the mean score ranking of a five-point Likert scale adopted using Strongly Agree = 5, Agree = 4, Neutral = 3, Disagree = 2, and Strongly Disagree = 1. A reliable database of professional suppliers with 4.46 MS and 0.670 Std Dev, and firms' long-term relationships with service providers with 4.46 MS and 0.609 Std Dev, ranked first; availability of suppliers with SCM knowledge ranked third with 4.40 MS and 0.634Std dev; effective government regulations ranked fourth with 4.38 MS and 0.530 Std dev; automated logistic systems ranked fifth with 4.37 MS and 0.715 Std dev; efficient information feedback systems with 4.33 MS and 0.706 Std dev, and manageable supply order cycles with 4.33 MS and 0.706 Std dev, ranked sixth; effective people and environmental management with 4.27 MS and 0.660 Std dev, and efficient operational practices with 4.27 MS and 0.490 Std dev, ranked eighth; and stakeholders' knowledge of SCM ranked tenth with 4.19 MS and 0.768 Std dev. Consequently, productivity measures of cost reporting ranked eleventh with 4.15 MS and 0.697 Std dev; effective inventory procedure ranked twelfth with 4.15 MS and 1.010 Std dev; effective collaborative working ranked thirteenth with 3.96 MS and 1.120 Std dev; cost competitiveness ranked fourteenth with 3.92 MS and 0.967 Std dev; use of digital technologies with 3.90 MS and 1.287 Std dev, and long-term relationships with service providers with 3.90 MS and 1.015 Std dev, ranked fifteenth. Equally, efficient operational practices ranked seventeenth with 3.88 MS and 1.078 Std dev; upfront planning and procurement ranked eighteenth with 3.87 MS and 1.284 Std dev; enhanced delivery performance ranked nineteenth with 3.77 MS and 1.059 Std dev; superior collaborative planning ranked twentieth with 3.75 MS and 1.100 Std dev; and quality assurance of materials delivery ranked twenty-first with 3.62 MS and 0.844 Std dev. The mean score values are greater than 3.50, indicating the importance of the twenty-one identified drivers of implementing supply chain management in construction project delivery (Opawole & Jagboro, 2016).

Furthermore, Table 2 shows the results of the Kruskal–Wallis non-parametric test that compares the perspectives of the respondents based on their professionals' designations (architects, construction managers, project managers, quantity surveyors, electrical engineers, civil engineers, town and regional planning, and others). Using a 95% confidence level, the result of the Kruskal-Walis test shows that five of the twenty-one identified drivers of implementing supply chain management in construction project delivery had a significant difference ranging from 0.000 to 0.035 below the recommended 0.05 (Yong & Pearce, 2013; Pallant, 2016) and Chi-Square values ranging from 15.112 to 27.298. The variables include effective people and environmental management p-value of 0.029, stakeholders' knowledge of SCM p-value of 0.035, Effective collaborative working p-value of 0.017, efficient operational practices p-value of 0.000, and enhanced delivery performance p-value of 0.004.

Table 2: Ranking of drivers of implementing supply chain management in construction project delivery

Identified drivers of implementing supply chain management	Mean	Std. Dev	Rank	Chi-Square	Asymp-Sig
Reliable database of professional suppliers	4.46	0.670	1	11.800	0.107
Firms' long-term relationships with service providers	4.46	0.609	1	9.594	0.213
Availability of suppliers with SCM knowledge	4.40	0.634	3	2.091	0.955
Effective government regulations	4.38	0.530	4	7.118	0.417
Automated logistic systems	4.37	0.715	5	8.467	0.293
Efficient information feedback systems	4.33	0.706	6	9.036	0.250

Manageable supply order cycles	4.33	0.706	6	12.593	0.083
Effective people and environmental management	4.27	0.660	8	15.585	0.029*
Efficient tracking and identification	4.27	0.490	8	6.026	0.537
Stakeholders' knowledge of SCM	4.19	0.768	10	15.112	0.035*
Productivity measures of cost reporting	4.15	0.697	11	6.411	0.493
Effective inventory procedure	4.13	1.010	12	8.105	0.323
Effective collaborative working	3.96	1.120	13	17.102	0.017*
Cost competitiveness	3.92	0.967	14	13.027	0.071
Use of digital technologies	3.90	1.287	15	7.169	0.411
Long-term relationships with service providers	3.90	1.015	15	12.364	0.089
Efficient operational practices	3.88	1.078	17	27.298	0.000*
Upfront planning and procurement	3.87	1.284	18	5.367	0.615
Enhanced delivery performance	3.77	1.059	19	21.020	0.004*
Superior collaborative planning	3.75	1.100	20	3.666	0.817
Quality assurance of materials delivery	3.62	0.844	21	13.469	0.061

5. DISCUSSION OF FINDINGS

The study findings show that the five top-ranked drivers of implementing SCM include a reliable database of professional suppliers, firms' long-term relationships with service providers, availability of suppliers with SCM knowledge, effective government regulations, automated logistic systems, and efficient information feedback systems. These findings align with Emuze and Smallwood (2013), who attributed inherent drivers of SCM to having a reliable database of professional suppliers and long-term relationships with service providers to improve project delivery. The study findings also support Cigolini et al. (2022) submission that the use of digital technologies and upfront planning and procurement help to establish the conditions for the supply chain to function effectively in project delivery. Furthermore, the study findings ranked manageable supply order cycles, efficient people and environmental management, efficient operational practices, and stakeholders' knowledge of SCM as drivers to influence the implementation of supply chain management in construction project delivery. The study findings provide an understanding that strengthens stakeholder relationships in the construction project delivery. In collaboration with Kwofie, Aigbavboa, and Matsane (2019), the study highlighted effective collaborative work, efficient operational practices, and effective people and environmental management drivers of supply chain management in construction project delivery. The study aligns with Fawcett et al. (2008) and Kwofie (2019), who believe supply chain management is characterised by transparent information systems, cross-functional collaboration, and collaborative planning to improve project delivery and performance. Consequently, the study emphasises drivers of supply chain management that will enhance construction resources planning, acquiring, coordinating and transportation. Nonetheless, supply chain management drivers in the construction industry play an essential role in improving the coordination and communication among stakeholders in a construction value chain for the quality and profitability delivery of construction projects. In addition to Tiwari et al. (2014), Doan (2020) and Cigolini et al. (2022), the study findings also emphasise the importance of digital technologies as drivers of supply chain management that improve coordination and communication among stakeholders in construction project delivery. Contrary to previous findings by Kwofie (2019) and Doan (2020) findings, efficient operational practices, upfront planning and procurement, enhanced delivery performance, superior collaborative planning, and quality assurance of materials delivery were the lowest-ranked drivers of supply chain management in project delivery in the study area.

6. Conclusion and Recommendations

This study explores the perspective of construction professionals in the construction industry in Durban, KwaZulu-Natal province, South Africa, to assess the drives of implementing supply chain management in construction project delivery. The study results indicate that specific drivers must be in place to implement supply chains effectively in project delivery. These include a dependable database of reliable, professional suppliers, long-term relationships between firms and service providers, the availability of suppliers with knowledge of supply chain management, effective government regulations, the implementation of automated logistic systems, efficient feedback systems for information, well-managed supply order cycles, effective management of people and the environment, efficient operational practices, and stakeholders' knowledge of supply chain management in construction project delivery. These drivers provide flexibility, improve coordination and communication, and strengthen stakeholder relationships in construction project delivery. The study findings highlighted drivers for implementing supply chain management by construction firms, stakeholders, professional institutions, and government agencies to increase the knowledge of SCM integration in project delivery. Likewise, the study recommends that the operations of firms, stakeholders, professional institutions, and government agencies in the construction industry be guided by drivers of supply chain management, including effective government regulations, integration of automated logistic systems, efficient feedback systems for information, and effective management of people and the environment. The study further recommends that stakeholders foster long-term relationships between firms and service providers, develop well-managed supply order cycles, and develop an effective database of suppliers with knowledge of supply chain management. The study's implications will enable construction professionals, stakeholders, government agencies, and professional institutions to identify and understand drivers of supply chain management in construction project delivery and the need to develop strategies and implement supply chain management in construction project delivery. The study findings were drawn from the data obtained from selected construction professionals in Durban, KwaZulu-Natal, one of the twelve provinces in South Africa, which limits the generalisation of the study findings in South Africa. Nonetheless, further study could explore a larger population involving professionals across the twelve provinces in South Africa compared to the findings of this study.

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