JCBM (2025) 8(S1) 72-87

University of Cape Town

Journal of Construction Business and Management

http://journals.uct.ac.za/index.php/jcbm

Factors Influencing Procurement in Construction: The Role of Clients and Construction Machinery in KwaZulu-Natal

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Received 07 October 2025; received in revised form 16 October 2025, 25 December 2025; accepted 27 December 2025
https://doi.org/10.15641/jcbm.8.S1.1930

Abstract

This study identifies the client and machinery-related factors and examines their interrelationships in construction procurement, employing a systems-thinking approach. Data from stakeholders (N=31) in the KwaZulu-Natal construction industry were collected through a survey using purposive sampling. The data were analysed using descriptive and inferential statistical methods, as well as Applied Systems Analysis (ASA), with causal loop diagrams (CLDs) illustrating how procurement performance evolves through reinforcing and balancing feedback loops. Findings indicate that clients' emphasis on cost and timely delivery strongly drives procurement decisions but can weaken decision-making, reduce communication, and increase project variations. Machinery-related challenges, including poor maintenance, high hiring costs, and limited access, further exacerbate inefficiencies. When considered together, balancing loops emerge, where strong governance, effective communication, preventive maintenance, and operator training stabilise and improve outcomes. The study contributes theoretically by advancing a systems-based perspective that integrates client governance and machinery management, and by identifying leverage points for policymakers, clients, and contractors, such as improving governance, embedding maintenance practices, aligning priorities with resource planning, and institutionalising feedback. Procurement effectiveness is thus shaped by interdependent governance, decision-making, resource management, and systemic learning.

Keywords: Applied Systems Analysis, Client, Construction, Machinery, Procurement, Governance

1. Introduction

The procurement process is a critical determinant of success in construction projects, covering activities from requirement identification through execution to closeout. Effective procurement ensures resources are secured and aligned with project objectives, while poor decisions often result in inefficiencies, delays, and cost overruns (Fleming, 2019). In construction, procurement is particularly complex due to the variety of available methods, competing trade-offs, and decision criteria shaped by project characteristics, client capabilities, and external constraints (Ruparathna & Hewage, 2015).

Clients play a central role in shaping procurement choices. Their technical expertise, prior experience, and willingness to assume responsibility significantly influence the selection of procurement methods (Plunkett, 2021). Experienced clients favour arrangements that provide greater involvement and control, whereas less experienced clients often prefer to transfer responsibility to contractors. Equally important are machinery-related factors: the availability, suitability, and operability of equipment strongly affect project feasibility and efficiency, particularly for complex projects requiring specialised tools. A lack of appropriate machinery not only threatens delivery but also constrains procurement strategy.

Despite extensive research on procurement practices, inefficiencies persist. Many approaches rely on linear cause-and-effect models, overlooking the interdependencies and feedback loops that shape outcomes. As a result, conventional strategies often fail

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to address the dynamic and systemic nature of procurement challenges.

Existing research identifies several factors influencing procurement method selection, including project characteristics (time, cost, scope, and complexity), owner capacity, and risk-allocation preferences. Increasingly, multi-criteria decision-making tools such as the Analytic Hierarchy Process (AHP) and the Analytic Network Process (ANP), along with related models, are employed to support these decisions (Suratkon et al., 2020; Franz & Leicht, 2016; Chen et al., 2016). However, while project- and risk-related drivers have received significant attention, client-specific characteristics and the availability of construction machinery remain underexplored. This gap is particularly relevant in regional contexts, such as KwaZulu-Natal, South Africa, where financial constraints, skill shortages, and limited resources significantly influence procurement performance.

Moreover, much of the existing literature has prioritised process optimisation and cost reduction, often neglecting the systemic and dynamic interactions that influence outcomes. Few frameworks capture causal feedback relationships or provide holistic strategies. This omission is critical, as project success depends on the interplay between client decision-making capacity and resource availability.

In response to this gap, the present study applies Applied Systems Analysis (ASA) to map causal feedback relationships within procurement systems and identify strategies to enhance procurement performance. By modelling the dynamic interactions among procurement variables, the research aims to generate actionable insights to improve efficiency, responsiveness, and overall organisational outcomes. Specifically, the study examines the influence of client-related and machinery-related factors on the selection of contract procurement methods in KwaZulu-Natal. By addressing these underexplored dimensions, the study seeks to align procurement strategies with client capacities and resource constraints, thereby supporting more effective and sustainable project delivery. Consequently, the four research questions (RQs)were investigated.

- RQ1: How do client-related factors and construction machinery considerations influence procurement method selection in KwaZulu-Natal?
- RQ2: What causal feedback relationships shape procurement performance?
- RQ3: How can ASA be applied to map and analyse these dynamics effectively?
- RQ4: What strategies, informed by a systems perspective, can enhance procurement methods and outcomes?

By integrating ASA, the research contributes a structured framework for identifying leverage points and designing interventions that address immediate inefficiencies while fostering long-term procurement improvements.

2. Literature Review

2.1. Procurement in Construction

Procurement in construction projects is a critical determinant of project success, as it involves acquiring goods and services essential to planning, execution, and closeout. More than purchasing, procurement encompasses relationship and contract management to ensure projects are delivered on time, within budget, and to the required standards. Its effectiveness directly impacts efficiency, cost control, and quality, making it a cornerstone of project performance.

Procurement provides the contractual framework through which clients engage participants to design, construct, and deliver facilities ready for use (Rowlinson, 2022). It secures competent contractors, ensures qualifications, and achieves services at reasonable cost (Fewings & Henjewele, 2019). Well-structured procurement reduces costly variations and delays, improving overall efficiency and outcomes.

The process typically unfolds in three stages: planning, execution, and closeout. Planning involves developing strategies, preparing tender documents, and evaluating bidders, setting the foundation by defining scope, cost, time, and quality requirements (Lester, 2014). Execution focuses on contract management, supplier evaluation, and negotiation, including requests for quotations, letters of intent, and purchase orders (Lester, 2014). Closeout ensures obligations are met, deliverables conform to standards, and handovers are correctly documented (Lester, 2014).

Procurement significantly shapes project outcomes. Timely procurement shortens schedules by streamlining supplier selection and contract administration (Basiru et al., 2022). Cost control is enhanced through efficient strategies, with automation and AI reducing processing times by over 30% in some organisations (Basiru et al., 2022). Quality is safeguarded by selecting qualified contractors and ensuring competitive pricing (Fewings & Henjewele, 2019). Efficiency is further strengthened by digitalisation and supplier relationship management, which support better decision-making (Basiru et al., 2022).

Despite its importance, procurement continues to face persistent challenges. Large projects with multiple stakeholders often involve complex processes that heighten risks and inefficiencies. Evolving methods, driven by technological innovation and sustainability goals, demand continuous adaptation. Nevertheless, robust procurement strategies remain vital to delivering cost-effective, timely, and high-quality construction outcomes.

2.2. Procurement Methods and Factors Influencing Construction

Procurement methods in construction are critical for project success, as they define execution frameworks, risk allocation, and stakeholder collaboration. Common approaches—traditional, design-build, and EPC (Engineering, Procurement, and Construction)—offer distinct advantages and challenges, making their selection a complex process. The choice depends on project characteristics, risk distribution, cost, schedule, and client preferences. To support decision-making, multi-criteria evaluation tools such as the Analytic Hierarchy Process (AHP), Analytic Network Process (ANP), TOPSIS, and Multi-Attribute Utility Theory (MAUT) are frequently employed (Soltanikarbaschi & Hammad, 2023; Liu et al., 2011; El-Sawalhi & Agha, 2017). Decision-making tools provide structured frameworks. For example, AHP derives weights for criteria based on client priorities (Soltanikarbaschi & Hammad, 2023; Liu et al., 2011), TOPSIS ranks alternatives against an ideal solution, and MAUT evaluates multiple criteria simultaneously, including cost and complexity (El-Sawalhi & Agha, 2017).

Several factors influence procurement in construction. Project size, type, and complexity dictate whether traditional or integrated approaches are more suitable, with larger projects favouring design-build or EPC frameworks (Zhong et al., 2022; El-Sawalhi & Agha, 2017). Risk allocation is also critical; design-build contracts often shift greater risk to contractors, while traditional methods distribute risks more evenly (Zhong et al., 2022; Bolomope et al., 2022). Budget and schedule considerations also matter, as design-build methods (which integrate design and construction under a single contract) can reduce costs and time by overlapping the design and construction phases (El Wardani et al., 2006). Client experience further influences decisions: experienced clients adopt innovative approaches, while less experienced clients tend to prefer traditional methods (El-Sawalhi & Agha, 2017).

Ultimately, no procurement method is universally superior. Achieving sustainability and efficiency in procurement requires careful assessment of project conditions, stakeholder goals, and market dynamics, supported by flexible, informed decision-making tools.

2.3. Client-Related Factors

Client-related factors in construction procurement are multifaceted, encompassing technical expertise, prior experience, and decision-making capacity, all of which significantly influence procurement selection and project performance. Client involvement in procurement processes is critical, enabling more informed decisions and improved project outcomes. Regional studies, particularly in KwaZulu-Natal, South Africa, highlight the importance of understanding local conditions, practices, and constraints (Aiyetan & Ayodabo, 2024).

Clients' technical expertise and experience are pivotal in selecting suitable procurement routes. Frameworks that incorporate clients' lived experiences and align procurement methods with project types can reduce cost overruns and delays, enhancing delivery (Bolomope et al., 2022). Client knowledge of procurement systems is positively correlated with performance outcomes, as those with a stronger understanding are more likely to achieve project objectives (Windapo et al., 2021). Evidence from Saudi Arabia supports this, demonstrating that knowledge, experience, and decision-making capacity are crucial for effective client involvement throughout project phases (Trigunarsyah & Al-Solaiman, 2015).

Active client involvement aligns project objectives with procurement choices. Effective briefing and selection processes contribute directly to achieving time, cost, and quality goals (Bowen et al., 1999). However, transitioning clients from passive funders to active participants has not constantly improved performance, highlighting the need for stronger organisational capabilities to support procurement decisions (Al-Harthi et al., 2014). In South Africa, the selection of a procurement system depends on both internal and external factors, with client knowledge and control being crucial for the successful implementation of such systems (Mathonsi & Thwala, 2012).

Context-specific studies emphasise tailoring procurement to local conditions. In KwaZulu-Natal, the project scope, budget, size, quality management, and risk management significantly influence the selection of procurement strategy (Aiyetan & Ayodabo, 2024). Broader South African studies also identify socio-economic factors, client requirements, capital cost, procurement policy, and project characteristics as key determinants, particularly across project phases (Mathonsi & Thwala, 2012).

Overall, client-related factors are central to procurement selection and project performance; however, integrating them effectively remains a challenge. The evolving role of clients demands strengthened internal structures and decision-making capabilities, yet improvements in project outcomes are not guaranteed, underscoring the need for ongoing research and development (Al-Harthi et al., 2014).

2.4. Construction Machinery Considerations

In construction procurement, machinery considerations are critical because they directly impact project efficiency, costs, and timelines. Selecting and managing equipment such as tower cranes, mobile cranes, concrete pumps, and excavators requires multi-criteria decision-making to optimise benefits and minimise challenges (Uğur, 2017). Effective equipment management—particularly in planning and selection—is vital for timely project completion, as it identifies necessary machinery, evaluates performance, and forecasts requirements (Chinchore & Khare, 2014).

Equipment selection must consider cost, productivity, and project-specific needs, since these strongly influence overall efficiency (Gates & Scarpa, 1980). Key factors include availability to prevent delays, suitability to match project requirements, and operational capacity to ensure efficient execution (Sakhare, 2024). Coordinated management enhances productivity and reduces downtime, especially in earthwork projects where soil types and environmental conditions affect schedules and budgets (Sakhare, 2024; Kumar & Mishra, 2024).

Procurement strategies must balance the ownership versus rental of machinery, considering idle time and long-term cost-effectiveness, including maintenance and lifecycle expenses (Gates & Scarpa, 1980; Fay et al., 2003). Efficient procurement also requires market analysis for advanced equipment and proper management of existing fleets (Sahu & Mohibullah, 2022).

Projects with specialised equipment face challenges such as downtime, operational inefficiencies, and cost overruns. Highway construction introduces complexities, including fuel supply, maintenance, and machinery transfer (Kumar & Mishra, 2024; Sahu & Mohibullah, 2022). Poor equipment management can be costly; one case study reported a 71.5% increase in costs and a 72% increase in project duration due to inadequate planning (Osman & Mohy, 2022). Addressing these issues through structured procurement strategies and comprehensive equipment planning is crucial to enhancing productivity, managing costs, and ensuring successful project delivery.

2.5. Systems Perspective in Procurement

Integrating systems thinking into construction procurement provides a holistic framework for understanding and improving procurement processes (Sterman, 2000). By examining interrelationships and feedback loops, systems thinking treats procurement as an interconnected system, rather than as a series of isolated activities, thereby enhancing decision-making and overall performance. In construction, where multiple stakeholders—including clients, contractors, and suppliers—interact, systems thinking helps identify and manage these interactions to improve efficiency and outcomes (Rowlinson & McDermott, 2005).

ASA complements this approach by providing structured tools for modelling and analysing complex systems, breaking them down into constituent parts and exploring their relationships (Barrad et al., 2018). ASA can model entire supply chains, revealing bottlenecks and inefficiencies, and supports informed decision-making (Ross-Smith & Yearworth, 2011). Feedback loops allow continuous assessment: positive loops amplify beneficial practices, while negative loops identify and mitigate risks (Barrad et al., 2018). Mapping causal relationships also clarifies how changes in one area affect others, helping to manage challenges such as cost overruns and schedule delays (Maulanisa et al., 2024).

ASA enables the simulation of scenarios to assess the impacts on project performance, thereby improving forecasting, resource allocation, and mitigation strategies for cost escalation and delays (Maulanisa et al., 2024; Love & Luo, 2018). It also supports performance tracking and auditing, helping projects remain on schedule and within budget (Ross-Smith & Yearworth, 2011).

Despite its advantages, implementing systems thinking and ASA is challenging due to project complexity, multiple stakeholders, and the dynamic construction environment. Adoption requires a cultural shift from linear to integrated approaches. Nevertheless, these methodologies offer substantial potential to enhance efficiency, inform decision-making, and improve outcomes in modern construction procurement.

2.6. Synthesis

Construction procurement has been conceptualised as a strategic and system-forming activity rather than a transactional process. The procurement of construction functionally structures contracts and manages risk, project objectives, and capabilities. It thus affects cost, time, quality, and overall performance. Inadequate construction procurement exacerbates delays, costs, and inefficiencies, whereas effective procurement strategies enhance coordination and predictability.

There is no superior procurement method; instead, efficiency depends on context, which is shaped by project complexity, risks, client capabilities, and market dynamics. The increasing Adoption of multi-criteria decision-making techniques suggests that making a procurement choice involves a multidimensional form of governance, rather than a purely technical act.

Factors relating to the client, most notably their knowledge, experience, and capacity for effective decision-making, clearly play a significant role in determining the level of purchasing success.

Nevertheless, increased client engagement does not necessarily contribute to better results without adequate capabilities being in place. Contingent-specific findings indicate that purchasing effectiveness is contextually entrenched in broader societal conditions. The procurement of machinery is another example of the systemic nature of procurement, as it directly affects productivity, costs, and schedules. Problems at this level of operations can feed into larger project inefficiencies.

A systems thinking perspective integrates these findings, considering procurement a complex adaptive system characterised by interdependencies and feedback. While systems-based approaches offer improved decision-making and risk management, their practical application remains constrained by organisational and cultural barriers. Overall, the literature reveals a persistent gap between recognising procurement as a strategic system and operationalising this understanding in practice.

3. Study context: Construction Industry in KwaZulu-Natal Province, South Africa

The construction industry in KwaZulu-Natal (KZN) plays a vital role in the provincial economy, although its contribution has declined in recent years. The sector accounted for approximately 2% of KZN's GDP in 2023/24, down from pre-2019 levels (KwaZulu-Natal Office of the Premier, 2024). In employment terms, KZN represents a substantial share of South Africa's construction workforce, with about 241,000 people employed in the third quarter of 2023 (Department of Employment and Labour, 2023). This underscores the industry's importance for job creation, despite persistent high unemployment, with official rates around 31% and expanded rates exceeding 44% (KwaZulu-Natal Office of the Premier, 2024).

The sector presents both opportunities and challenges. Infrastructure investments in transport, water, and civil works offer project prospects and have supported improvements in project awards (Industry Insight, 2025). However, project cancellations, postponements, cash-flow constraints, payment delays, rising input costs, and financial pressures undermine planning, resource allocation, and timely machinery procurement (Master Builders KwaZulu-Natal, 2024). Skills shortages and capacity constraints, particularly among small, medium, and micro-enterprises (SMMEs), further exacerbate inefficiencies, delays, and cost overruns (Ntuli & Allopi, 2014). Non-technical risks, including site invasions, intimidation, and procurement disputes, increase costs and erode investor confidence (Master Builders KwaZulu-Natal, 2024). Despite these challenges, KZN maintains a strong base of construction professionals in urban centres such as Durban and Pietermaritzburg.

Financial constraints and decision-making challenges among clients significantly affect procurement, often leading to delays in tendering, contract awards, and payments. Machinery availability and allocation—affected by cost pressures, late payments, or poor planning—also impact project execution. By analysing these client- and machinery-related factors using surveys, ASA, and causal loop diagrams, this study situates procurement challenges within KZN's broader construction dynamics.

Overall, the KZN construction industry combines opportunity and fragility. While it remains a key employer and infrastructure enabler, financial pressures, regulatory complexity, and external risks highlight the need for more resilient procurement systems to enhance project performance.

4. Research Methods

4.1. Data collection

Data for this study were collected using a structured questionnaire survey and a purposive sampling process designed to capture expert opinions on the research variables. A five-point Likert scale was used to measure the respondents' perceptions, allowing for both quantitative analysis and the expression of varying levels of agreement or importance. The Likert scale is widely adopted in construction management and social science research as it provides a reliable means of quantifying subjective judgments (Bryman, 2016).

A total of sixty-five (65) questionnaires were distributed to construction professionals in KwaZulu-Natal Province, South Africa. The targeted respondents included architects, quantity surveyors, project managers, contractors, finance and procurement professionals and engineers who were actively engaged in the construction industry. This ensured that the data were sourced from individuals with relevant expertise and direct involvement in construction projects, thereby enhancing the credibility and relevance of the findings (Fellows & Liu, 2015).

Of the 65 questionnaires, forty-five (45) were administered in person, facilitating direct engagement with respondents and reducing the likelihood of non-responses. Out of these, thirty-one (31) completed questionnaires were retrieved, representing a response rate of approximately 69%. This is considered acceptable for survey-based research in the construction management field, where response rates often range between 30% and 60% (Akintoye, 2000; Moser & Kalton, 2017). The achieved response rate indicates reasonable representativeness and suggests that the data obtained are reliable for analysis.

The adequacy of the sample size in survey research is often context-dependent. While the final number of usable responses (31) is modest, it is sufficient for exploratory analysis and for generating insights into professional perspectives within the provincial construction sector. Although the limited sample size may pose challenges for statistical inference, prior studies in construction management have reported similar or smaller sample sizes, especially when targeting experts in specific professional groups (Doloi, 2008). Moreover, the use of purposive sampling—targeting professionals with relevant expertise—ensures that the collected responses are highly informative, compensating for the relatively small sample size (Fellows & Liu, 2015).

Overall, the survey administration process, expert-based respondent selection, and acceptable response rate provide confidence in the validity of the data for subsequent analysis.

4.2. Data Analysis

The data collected through the questionnaire survey were analysed to investigate the influence of client-related and machinery-related factors on procurement in construction projects. Given that the responses were measured on a five-point Likert scale, descriptive statistics were used to summarise and interpret respondents' perceptions.

The primary statistical measures used were the Mean Score (Perception Index-PI), Standard Deviation (SD), Interquartile Range (IQR), and Coefficient of Variation (CoV). These measures provide complementary insights into the central tendency, variability, and consensus of professional opinions:

Perception Index: The mean score for each factor was computed to determine its relative importance as perceived by respondents. Higher mean values indicate stronger agreement on the factor's influence on procurement. This approach is widely adopted in construction management studies where Likert-scale responses are aggregated into a perception index to rank critical factors (Akintoye, 2000; Doloi, 2008).

Standard Deviation (SD): The standard deviation was calculated to assess the dispersion of responses around the mean. Lower SD values suggest greater consensus among respondents, whereas higher values indicate divergent opinions.

Interquartile Range (IQR): The IQR was used to further assess variability by focusing on the middle 50% of responses. This is particularly useful in Likert-based data, where extreme values can sometimes distort measures of variability. A smaller IQR reflects a tighter clustering of professional views, enhancing confidence in the ranking of the factors.

Coefficient of Variation (CoV): The CoV, expressed as the ratio of the standard deviation to the mean, was used as a relative measure of dispersion. By normalising the variability across different factors, the CoV allows for comparability between factors with different mean scores (Fellows & Liu, 2015).

A further non-parametric test (Chi-square test p-values) was conducted to examine whether the observed distribution of Likert-scale responses for each factor differed significantly from a uniform (random) distribution. The null hypothesis (H_0) for each factor was that respondents' ratings were evenly distributed across the Likert scale, implying no consensus regarding the factor's influence on procurement. Rejection of H_0 ($p < 0.05$) therefore indicates that the observed responses were not random and that there was statistically significant agreement among respondents regarding the importance of that factor. The Chi-square test was not used as a test of independence between variables, but rather as a supporting test of response consistency and consensus, complementing the descriptive statistics.

The use of these combined statistical measures ensured not only the identification of the most influential client and machinery factors but also the assessment of the consistency of expert judgments. Factors with higher mean scores and lower variability (low SD, narrow IQR, smaller CoV, and p-values less than 0.05) were considered both significant and stable in terms of respondent agreement.

The ranked perception indices and associated measures were subsequently integrated into ASA-linked causal loop diagrams, enabling the mapping of interrelationships between procurement-related factors. This approach facilitated the development of causal feedback structures within the construction procurement system, providing deeper insights into how client- and machinery-related drivers interact dynamically to influence project outcomes.

4.3. ASA for crafting CLDs

To examine the dynamic interrelationships between client- and machinery-related factors affecting construction procurement, this study employed the Applied Systems Analysis (ASA) method. ASA integrates expert-based data with systems thinking tools to conceptualise and analyse complex management problems (Checkland, 1999; Sterman, 2000).

ASA is particularly suited for construction procurement, which involves multiple stakeholders, competing objectives, and resource interdependencies.

It provides a holistic view of interconnected factors rather than treating them in isolation (Williams, 2005). ASA also enables the integration of quantitative data with qualitative insights, combining measurable variables (e.g., machinery availability) with judgment-based factors (e.g., client decision-making flexibility)

(Checkland, 1999; Fellows & Liu, 2015).

A key advantage of ASA is its dynamic perspective: causal loop diagrams (CLDs) capture feedback mechanisms and time delays, revealing not only which factors are influential but also how they interact over time (Sterman, 2000). The visual representation of procurement drivers also serves as a practical decision-support tool, helping practitioners anticipate unintended consequences and identify leverage points for improving performance (Forrester, 1961).

In this study, construction procurement was conceptualised as a system of interacting factors, rather than as a linear sequence of activities. Survey data—including mean PIs, SDs, IQR, and CoVs—were analysed to inform the ASA process by identifying critical factors and assessing levels of stakeholder consensus and uncertainty. These quantitative insights guided the development of CLDs, which illustrate how client requirements, decision-making behaviours, and machinery availability interact through reinforcing and balancing feedback loops to shape procurement outcomes (Forrester, 1961; Williams, 2005).

The CLDs were developed using a theory-informed, data-driven analytical approach, rather than through direct respondent validation methods such as group model building. Following the quantitative analysis, the authors constructed diagrams by integrating empirical findings from the questionnaire survey (including ranked perception indices and measures of variability), established literature on construction procurement and systems thinking, and expert judgement grounded in prior research and domain knowledge.

Although respondents did not directly validate the CLDs, their aggregated perceptions provided a robust empirical basis for factor selection and prioritisation. At the same time, ASA principles were used to interpret and formalise the causal relationships.

The CLD development process was systematic and iterative. Client-related and machinery-related factors were initially identified through a comprehensive literature review and subsequently refined using survey data. Factors were prioritised based on PI values, supported by measures of response consistency. Initial cause–and–effect relationships were then established by combining empirical rankings with theoretical insights and logical reasoning consistent with construction practice.

The resulting causal structures were iteratively refined to enhance internal consistency, logical coherence, and alignment with real-world procurement dynamics, including the identification of reinforcing and balancing feedback loops.

The final CLDs were embedded within an ASA framework to represent construction procurement as a dynamic system, enabling analysis of the interactions between client- and machinery-related factors and their cumulative effects on construction project outcomes.

Causal relationships were assigned polarities: positive (+) indicates a direct relationship, and negative (–) indicates an inverse relationship (Sterman, 2000). Reinforcing loops amplify changes, such as increased client demands intensifying procurement delays, while balancing loops stabilise the system, for example, timely machinery allocation mitigating delays. Including both loop types provides a nuanced understanding of how procurement performance evolves, highlighting persistent challenges and mechanisms for control.

Overall, ASA offers a rigorous, systems-oriented framework that situates client- and machinery-related factors within a dynamic causal structure, moving beyond simple factor rankings to provide both analytical insights and practical guidance for enhancing procurement effectiveness in construction projects.

5. Results and Discussion

5.1. Profile of respondents

Table 1 presents the profile of respondents, reflecting a balanced and diverse representation of stakeholders in KwaZulu-Natal's construction sector.

Project Managers constituted the largest group (22.58%), followed by Contractors (19.35%), Engineers (16.13%), Architects (12.90%), Clients (19.35%), and Quantity Surveyors (9.68%). Most respondents held a bachelor's degree (45.16%), with 35.48% having a diploma and 19.35% possessing honours or postgraduate qualifications, indicating strong academic grounding. In terms of professional experience, the majority reported 11–15 years (70.97%), followed by 5–10 years (19.35%) and over 16 years (9.68%), demonstrating substantial expertise. This combination of diverse roles, qualifications, and experience ensures that both professional and client perspectives are captured, enhancing the credibility and validity of the study's findings.

Table 1: Profile of respondents

Respondent's profile	Number	Per cent
Type of respondents		
Architects	4	12.90
Quantity Surveyors	3	9.68
Clients	4	12.90
Project Managers	7	22.58
Contractors	6	19.35
Clients	2	6.45
Engineers	5	16.13
Total	31	100
Qualification		
Diploma	11	35.48
Bachelors	14	45.16
Honours and Postgraduate	6	19.35
Total	31	
Experience		
5-10 years	6	19.35
11-15 years	22	70.97
>16 years	3	9.68
Total	31	100

5.2. Client-linked factors influencing procurement in construction

Table 2 presents Client-linked factors influencing procurement in construction. Client-linked factors influencing procurement revealed that cost and time are the most critical considerations. Among client-linked factors, the client's emphasis on low construction cost was rated the most influential, with a high mean score of (4.61), a relatively low standard deviation (SD) of (0.495), a CoV of (10.7%), an IQR of (1.0), and a p-value of (0.281). This demonstrates broad agreement among respondents that cost considerations dominate procurement choices. Similarly, the client's emphasis on timely project delivery was also critical, recording a mean of (4.39), SD (0.667), CoV (15.2%), IQR (1.0), and a significant p-value of (0.018). These two factors confirm that clients primarily drive procurement decisions based on affordability and completion speed.

Moderately influential was the type of client's funding, with a mean of (3.94), SD (0.814), CoV (20.7%), IQR (2.0), and p-value (0.879). This suggests the funding source is less significant compared to cost and time. In contrast, several client factors scored notably lower. The client's ability to brief was recorded as a mean of (2.74), SD (0.682), CoV (24.9%), IQR (1.0), and p-value (0.044), highlighting limitations in articulating project requirements. The client's ability to make decisions scored even lower at (2.48), SD (0.677), CoV (27.2%), IQR (1.0), and a highly significant p-value of (<0.001), underscoring decision-making as a critical weakness. Likewise, the client's contribution to design

Table 2: Client-linked factors influencing procurement in construction

S/N	Factor	Mean score	Standard deviation	CoV	IQR	p-Values
1	Client's emphasis on timely project delivery	4.39	0.667	15.2	1.0	0.018
2	Client's emphasis on low construction cost	4.61	0.495	10.7	1.0	0.281
3	Type of client's funding	3.94	0.814	20.7	2.0	0.879
4	The client's ability to brief the procurement team	2.74	0.682	24.9	1.0	0.044
5	Client's ability to make a decision	2.48	0.677	27.2	1.0	<0.001
6	Client's contribution to design and construction	2.39	0.667	28.0	1.0	0.018
7	Client's experience in construction	1.87	0.619	33.1	1.0	0.003

and construction registered a mean of (2.39), SD (0.667), CoV (28.0%), IQR (1.0), and p-value (0.018). In contrast, the client's prior experience in construction was rated the lowest with a mean of (1.87), SD (0.619), CoV (33.1%), IQR (1.0), and p-value (0.003).

Collectively, these results indicate that although cost and time dominate procurement priorities, weak technical capacity, poor decision-making, and limited client involvement pose significant challenges to procurement effectiveness.

5.3. Machinery-linked factors influencing procurement in construction

Table 3 presents machinery-linked factors influencing procurement in construction. These factors were also highlighted as significant constraints on procurement. Poor maintenance of tools and machinery emerged as the most pressing issue with a mean score of (4.55), SD (0.568), CoV (12.5%), IQR (1.0), and a highly significant p-value (<0.001). This was closely followed by difficulties in hiring construction tools and machinery (mean = 4.52; SD = 0.570; CoV = 12.6%; IQR = 1.0; p = 0.001), and the increase in hiring costs (mean = 4.45; SD = 0.723; CoV = 16.2%; IQR = 1.0; p = 0.008). These factors confirm that affordability and access to machinery are substantial barriers. Inadequate skills of machinery operators were also rated high (mean = 4.35; SD = 0.661; CoV = 15.2%; IQR = 1.0; p = 0.020), as was the insufficient number of machines available on-site (mean = 4.29; SD = 0.739; CoV = 17.2%; IQR = 1.0; p = 0.115), pointing to operational inefficiencies in equipment management.

Table 3: Machinery-linked factors influencing procurement in construction

S/N	Factor	Mean score	Standard deviation	CoV	IQR	p-values
1	Poor maintenance of tools and machinery	4.55	0.568	12.5	1.0	<0.001
2	Difficulties in hiring construction tools and machinery	4.52	0.570	12.6	1.0	0.001
3	Increase in the hiring cost of construction machinery	4.45	0.723	16.2	1.0	0.008
4	Inadequate skills of the machinery operator	4.35	0.661	15.2	1.0	0.020
5	Insufficient number of machinery available on-site	4.29	0.739	17.2	1.0	0.115
6	Damage to tools and machinery	4.16	0.583	14.0	1.0	<0.001
7	Absolute machinery used in construction operations	2.58	0.564	21.9	1.0	0.008
8	Complexities in the operation of machinery	1.84	0.638	34.7	1.0	<0.001*

*Asymptotic significance is displayed

Other machinery-linked concerns, though rated lower, remain relevant. Damage to tools and machinery was noted with a mean of (4.16), SD (0.583), CoV (14.0%), IQR (1.0), and a significant p-value (<0.001). Meanwhile, absolute (outdated) machinery scored much lower at (2.58; SD = 0.564; CoV = 21.9%; IQR = 1.0; p = 0.008), and complexities in machinery operations were rated the least influential (mean = 1.84; SD = 0.638; CoV = 34.7%; IQR = 1.0; p < 0.001).

These findings indicate that the core machinery-related challenges are less about outdated or overly complex equipment and more about affordability, accessibility, maintenance, and operator competence.

5.4. Conceptual Frameworks using CLDs based on Systems Thinking

5.4.1. Client-Related Factors and Feedback Loops

Client-related factors play a central role in determining procurement performance in construction projects. The reinforcing loop (R1 – Pressure Loop) illustrates how a client's emphasis on low costs and fast delivery, while initially beneficial, may create unintended negative consequences (Figure 1: The Client-Related CLD). Increased pressure for affordability and timeliness results in tighter procurement schedules, which often weaken decision-making capacity. This leads to project variations that cause delays and overruns, further intensifying cost and time pressures and perpetuating a cycle of inefficiency that negatively affects procurement.

In contrast, the balancing loop (B1 – Governance Loop) demonstrates the stabilising influence of effective governance and communication. Strong client governance fosters clear communication and integration with contractors, thereby improving procurement alignment, reducing delays, and enhancing procurement outcomes (Figure 1: The Client-Related CLD) (Watermeyer, 2022; Jagtap, Kamble, & Raut, 2017; De Blois et al., 2011).

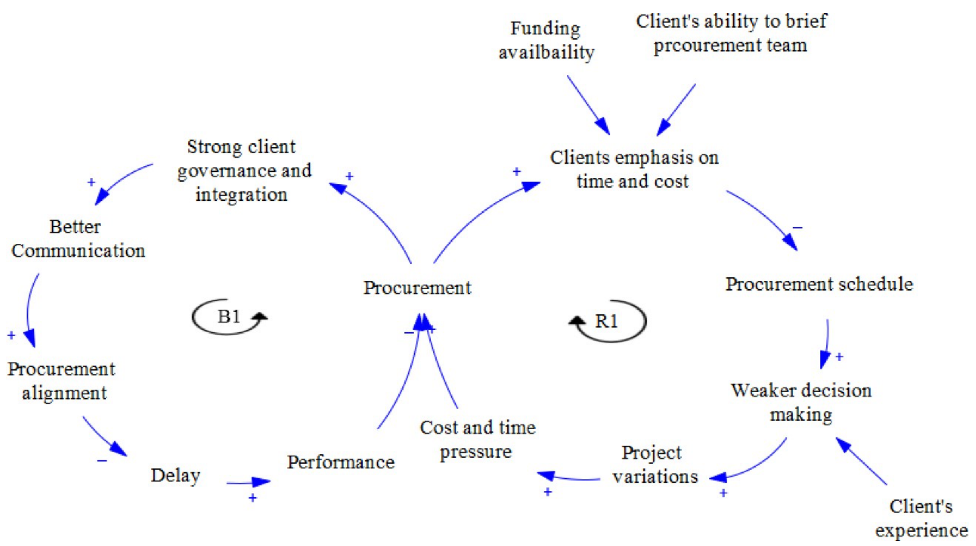

Figure 1: The Client-Related CLD

5.4.2. Machinery-Related Factors and Feedback Loops

Machinery availability, affordability, and maintenance are equally critical to procurement performance. The reinforcing loop (R2 – Cost-Access Loop) illustrates how high equipment hiring costs limit access to machinery, resulting in delays and overruns that, in turn, exacerbate cost pressures (Figure 2: The Machinery-Related CLD). This creates a cycle of inefficiency in resource utilisation.

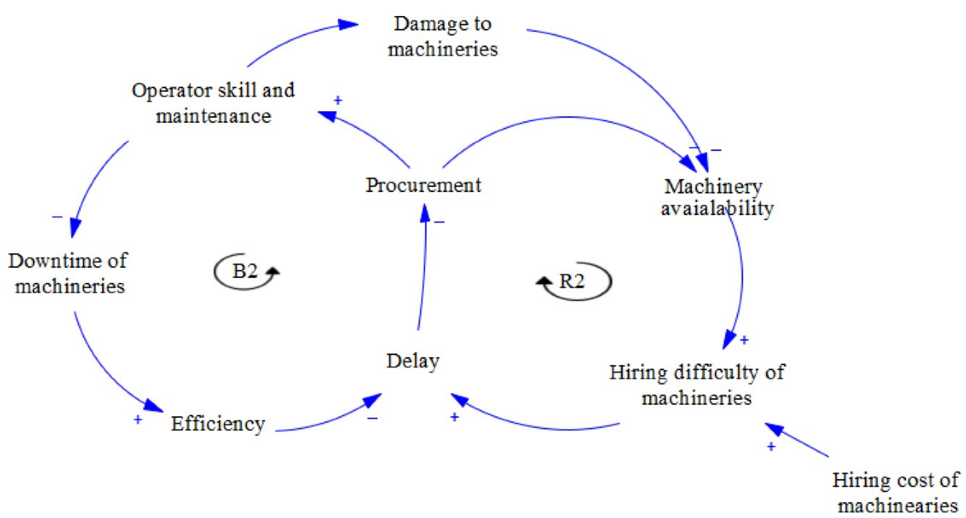

Figure 2: The Machinery-Related CLD

The balancing loop (B2 – Capacity Loop) demonstrates, however, that proper maintenance practices and skilled operators significantly improve efficiency. These factors reduce downtime and delays, thereby stabilising procurement (Figure 2: The Machinery-Related CLD) (Samee & Pongpeng, 2016; Osman & Mohy, 2022).

5.4.3. Integrated Client–Machinery Interplay

The integrated CLD reveals the dynamic interplay between client and machinery-related factors. The reinforcing loop (R3 – Misalignment Loop) highlights how client priorities and weak client decision-making undermine machinery planning, leading to delays, a downward spiral of inefficiency, and a negative impact on procurement (Figure 3: The Integrated CLD).

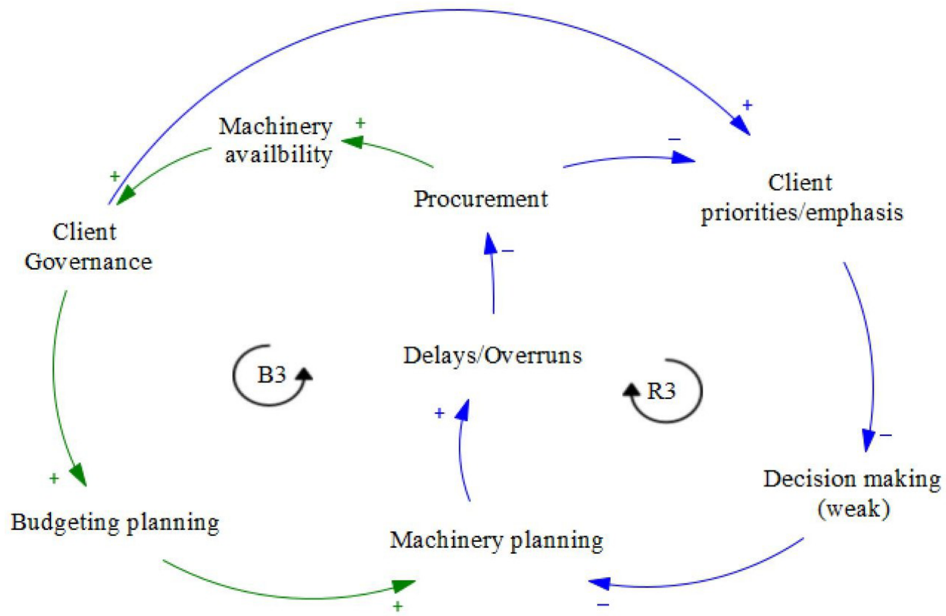

Figure 3: The Integrated CLD.

Conversely, the balancing loop (B3 – Strategic Integration Loop) demonstrates how robust client governance strengthens machinery budgeting and planning, ensuring that machinery planning improves procurement and enhances equipment availability (Figure 3: The Integrated CLD) (Al-Bayati et al., 2023; Lam & Gale, 2023)

The CLDs show that procurement outcomes are driven by reinforcing loops that amplify inefficiencies and balancing loops that stabilise performance. Strengthening balancing loops (B1–B3) and weakening reinforcing loops (R1–R3) through enhanced client governance, improved communication, effective machinery management, and systemic learning can transform procurement into a resilient, efficient, and value-driven process.

6. Discussion

The findings from this study reveal that both client-related and machinery-related factors significantly influence the effectiveness of procurement systems in construction. When interpreted through the conceptual framework developed using ASA and CLDs, these findings illuminate the dynamic feedback structures that underlie procurement performance.

6.1. Client-Related Dynamics in Procurement

The results indicate that clients' emphasis on cost and time dominates procurement decision-making, with affordability and timely delivery as the most influential considerations (mean scores>4.0). This aligns with prior studies that highlight clients' prioritisation of short-term cost savings and schedule adherence over broader value considerations (Bowen et al., 1999; Watermeyer, 2022). However, the study also found significant weaknesses in client decision-making capacity, briefing ability, and technical experience, with mean scores below 3.0. These weaknesses resonate with earlier work suggesting that limited client expertise and involvement contribute to procurement inefficiencies and project delays (Al-Harthi et al., 2014; Trigunarsyah & Al-Solaiman, 2015).

The reinforcing Loop (R1 – Pressure Loop) explains this pattern: intensified cost and time pressures strain decision-making capacity, leading to increased variations and undermining performance. In contrast, the balancing loop (B1 – Governance Loop) suggests that stronger governance and communication can mitigate these effects by enhancing alignment and coordination (Figure 1). This highlights that interventions aimed at strengthening governance, decision-making skills, and integration mechanisms are essential leverage points for stabilising procurement outcomes.

6.2. Machinery-Related Dynamics in Procurement

Machinery-related findings emphasise affordability and accessibility challenges. Poor maintenance, difficulties in hiring, and rising costs (PIs>4.0) were rated as critical barriers. These findings support the literature emphasising the importance of equipment availability, maintenance, and lifecycle management in ensuring project success (Chinchore & Khare, 2014; Samee & Pongpeng, 2016). Moreover, outdated or complex machinery was not viewed as a significant issue, suggesting that the immediate challenge lies less in adopting technology and more in ensuring operational reliability and access.

The reinforcing loop (R2 – Cost-Access Loop) captures a systemic explanation: high hire costs reduce availability, triggering delays that further intensify cost pressures. The balancing loop (B2 - Capacity Loop) demonstrates that preventive maintenance and operator competence can stabilise system performance by reducing downtime (Figure 2), consistent with evidence linking maintenance and training to productivity gains (Osman & Mohy, 2022).

6.3. Integrated Client–Machinery Interplay

The integration of client and machinery factors reveals a critical finding: client decision-making weaknesses exacerbate machinery procurement challenges. Weak governance and poor planning lead to insufficient machinery allocation, delays, and dissatisfaction, which reinforce client–contractor tensions. This reflects the reinforcing loop (R3 – Misalignment Loop) in the framework, where misaligned priorities perpetuate inefficiencies. On the other hand, the balancing loop (B3 – Strategic Integration Loop) illustrates how strong governance, strategic budgeting, and planning for machinery availability can enhance performance and foster positive cycles of satisfaction and governance reinforcement (Figure 3).

This interplay resonates with recent literature emphasising the need for procurement approaches that integrate both client-side governance and resource-side management (Lam & Gale, 2023; Al-Bayati et al., 2023). It suggests that focusing on a single dimension (e.g., client governance without addressing machinery access) is insufficient for sustainable procurement improvement.

6.4. Leverage Points in the Procurement System

From the CLDs, several leverage points emerge where targeted interventions can yield significant systemic improvements:

***Strengthening Client Governance and Decision-Making Capacity*:** Weak decision-making reinforces inefficiencies (R1, R3). Capacity-building initiatives, improved training, and structured governance frameworks reduce project variations and delays (Watermeyer, 2022).

***Enhancing Communication and Integration*:** Strengthening the governance loop (B1) requires improved communication between clients and contractors. Joint planning workshops, digital coordination platforms, and trust-building mechanisms mitigate adversarial dynamics (De Blois et al., 2011).

***Optimising Machinery Procurement and Maintenance*:** Addressing and reinforcing inefficiencies in machinery (R2) requires preventive maintenance, operator training, and lifecycle cost planning. These interventions stabilise procurement outcomes by improving efficiency (Samee & Pongpeng, 2016; Osman & Mohy, 2022).

***Aligning Client Priorities with Resource Planning*:** Using multi-criteria decision-making tools ensures procurement decisions balance cost, time, and machinery needs, mitigating misalignment (Soltanikarbaschi & Hammad, 2023).

***Institutionalising Feedback and Learning*:** Strengthening balancing loops depends on systematic feedback. Post-project reviews and knowledge management practices embed lessons learned into future procurement decisions (Love & Luo, 2018).

6.5. Implications for Research and Practice

The findings, interpreted through the systems-based framework, yield several implications:

6.5.1. Theoretical Implications

This study advances procurement research by adopting a systemic perspective, highlighting how reinforcing and balancing loops link cost pressures, decision-making, and machinery management. By integrating client- and machinery-related factors, it addresses a literature gap, moving beyond isolated analyses of governance or equipment management (Ruparathna & Hewage, 2015; Bolomope et al., 2022).

6.5.2. Practical Implications

Strengthening client governance and decision-making is a priority, with training, procurement guidelines, and institutional reforms serving as leverage points to break reinforcing inefficiency loops. Investment in machinery maintenance and operator training, including preventive maintenance and lifecycle planning, stabilises procurement performance. Integrating governance with machinery planning using multi-criteria decision-making tools (AHP, TOPSIS) balances cost, quality, and resources (Soltanikarbaschi & Hammad, 2023). Systematic feedback, through post-project reviews and knowledge management, strengthens balancing loops and improves procurement practices (Love & Luo, 2018).

7. Conclusion

This study examined the interrelationships between client- and machinery-related factors in construction procurement using a systems-thinking approach. By integrating survey findings from the KwaZulu-Natal

construction industry with CLDs, a dynamic understanding of how procurement performance evolves through reinforcing and balancing feedback loops was provided.
Results confirm that clients' focus on cost and timely delivery strongly drives procurement decisions, but these priorities often weaken decision-making capacity, reduce communication, and increase project variations. Machinery-related challenges—including poor maintenance, high hiring costs, and limited access—also exert pressures on project efficiency. Considered in isolation, these factors reinforce inefficiencies. However, when viewed through a systems lens, balancing loops emerge: strong governance, effective communication, preventive maintenance, and operator training stabilise and improve procurement outcomes.

The study contributes both theoretically and practically. It advances procurement research by moving beyond linear analyses to a systems-based perspective, highlighting the dynamic interaction between client governance and machinery management. It addresses a literature gap by integrating these dimensions, which are often studied separately. Practically, it identifies leverage points for policymakers, clients, and contractors: strengthening governance and decision-making, embedding preventive maintenance, aligning client priorities with resource planning, and institutionalising lessons learned through feedback systems. By combining empirical evidence with systems thinking, the study demonstrates that procurement effectiveness depends on interdependent governance, decision-making, resource availability, and feedback learning rather than cost control alone.

Limitations include the single-provincial context, which may restrict generalisability, and the reliance on perceptual survey data, suggesting a need for triangulation with project performance records or longitudinal studies. Future research should apply ASA and CLDs across diverse regions and project types, test interventions at leverage points, and explore digital technologies like BIM and predictive analytics to enhance machinery management. Overall, the study demonstrates that effective procurement stems from dynamic governance, decision-making, machinery, and systemic learning, providing a pathway to resilient, efficient, and value-driven construction procurement systems.

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