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Barriers to the Implementing Lean Design and Construction in Kenya

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Abstract

This study examines the barriers to lean design and construction implementation in Kenya, emphasising the need for an integrated approach that combines leadership commitment, proper training, cultural change, and effective project management. The literature review identifies key barriers, including inadequate management commitment, lack of training in lean principles, absence of a lean culture, unclear roles and responsibilities, insufficient technical knowledge, poorly managed project planning, and external factors such as fluctuations in customer demand. A mixed-method research approach, encompassing both quantitative and qualitative methodologies, is adopted, targeting professionals in the construction industry, including architects, quantity surveyors, engineers, and building contractors of NCA Category 6 and above. Stratified simple random sampling was employed from which a representative sample was selected. Data collection involves a customised questionnaire designed to assess opinions regarding barriers to implementing lean in design and construction processes. The results aim to highlight the challenges faced and provide insights into enhancing productivity and value within the Kenyan construction sector. Five main challenges were identified, namely: poor contract administration, lack of lean culture, leadership disconnect, cost and market barriers, and employees' inertia.

Keywords: Barriers, lean design, lean construction, value, Exploratory Factor Analysis (EFA)

INTRODUCTION

There are proven benefits to applying lean principles in other industries, such as manufacturing, defence, and motor vehicle production. However, the construction industry still faces challenges in adopting and implementing lean design and construction (Ahmed & Sobuz, 2019). A case study conducted by Chaudhary et al (2022) has identified barriers that create a gap between the perceived benefits and actual implementation of lean tools in design and construction. These tools include the Last Planner System (LPS), Target Value Design (TVD), Concurrent Engineer-ing (CE), and Integrated Project Delivery (IPD), which have been successfully applied to pro-jects with demonstrable results (Rosas, 2013; Safdari, 2018).

The challenge with adoption relates to traditional approaches to project management, which often involve design being isolated from construction (broken workflow), adversarial contractual relationships, and resistance to change (Chaudhary, 2022). The results of such inefficient ap-proaches are delays, cost overruns and poor quality, which are compounded by a lack of coordi-nation in design and actual construction on sites (Gupta et al., 2020; Musonda et al., 2024). Un-derstanding these barriers is a crucial first step in adopting effective strategies to overcome them, thereby facilitating collaboration and continuous improvement. These are considered key to increasing value and eliminating waste in the design and construction process.

THEORY

Lean construction focuses on improving productivity. Gupta et al. (2020) note that the reduction in profit margins in the construction industry over the years necessitates a shift in managerial tools, as well as efforts to enhance efficiency and productivity. Mossman (2009)

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and Moradi & Sormunen (2023) contends that lean construction promises to generate value for clients and stakeholders in the production chain while eliminating waste, it still faces several barriers, namely: lean construction leadership and management commitment; training and continuous improvement; organisational culture; people involvement; unclear roles and responsibilities of people in the process; technical knowledge; create and manage projects; and external factors:

These barriers underscore the necessity for an integrated approach to implementing Lean, which involves combining leadership commitment and proper training with cultural change and effective project management (Gupta et al., 2020; Negi et al., 2024). Chaudhary et al. (2022) identified the primary barriers to implementing lean construction as delays due to changes in plans, insufficient storage space for materials, and inadequate equipment. Araújo et al. (2021) conducted a case study on the implementation of the pull system. They noted that the main barriers revolved around leadership, a lack of awareness of lean among the people involved, which was compounded by a lack of lean culture and uncoordinated design and construction processes.

RESEARCH METHODS

This study employed a mixed-methodology research method (Creswell, 2014). The target population consisted of professional firms in the construction industry, specifically those in the categories of Architectural, Quantity Surveying, Civil and Structural Engineering, Elec-trical and Mechanical Engineering, and Building and Roads Contractors (NCA Category 6 and above). Design consultants and contractors of NCA 6 and above were deemed to have vast ex-perience, hence able to provide opinions on waste-producing factors, barriers to the implemen-tation of lean construction and their practice/awareness of various lean construction principles. Stratified simple random sampling was used for each group of the identified population. The sampling frame consisted of 13,789 firms: 509 consulting firms and 13,280 contractors (**Table 1**).

Preferably, the professionals' sample from a specific firm is taken, as representatives of that firm, and the ideas expressed by these professionals constitute the professional practice of that particular firm. This approach eliminates the problems that arise from sampling frame bias, as registered industry players who undertake formal construction.

The study identified variables through a literature review, specifically those relating to lean de-sign and construction. These approaches resulted in a total of 17 variables that are considered barriers to lean implementation. Two slightly differentiated questionnaires were designed, with items customised to capture the opinions of contractors on one hand and designers (architects, civil engineers, quantity surveyors, project managers, electrical engineers, and mechanical en-gineers) on the other.

The barriers to lean implementation were analysed on a 5-point scale, as summarised in **Table 2**. Respondents rated their opinions on the barriers to implementing lean principles in the design and

TABLE 1
Survey target population

Type of Firm	Population		Sample Size
Architectural	263		26
Quantity Surveying	166		17
Engineering Consulting Firms (Civil)	166		17
Construction Project Managers	11		11
Engineering Consulting Firms (Elec-trical)	33		4
Engineering Consulting Firms (Me-chanical)	24		3
Building Contractors NCA 6 and above	13,280		20
Total	**13,943**		**98**

Source: Field Survey, 2024

TABLE 2
Questionnaire design

		Variable	Author and Year	
DQQ37	CQQ37	Insufficient Awareness	Sarhan & Fox 2013	1 represented 'strongly agree' while 5 repre-sented 'strongly disagree'
DQQ38	CQQ38	Resistance to change	Moradi & Sormunen, 2023	
DQQ39	CQQ39	Insufficient support from senior leadership	Sarhan & Fox 2013; Moradi & Sormunen, 2023	
DQQ40	CQQ40	Challenges with coopera-tion	Moradi & Sormunen, 2023	
DQQ41	CQQ41	Lack of relevant incentives	Mossman, 2009	
DQQ42	CQQ42	Competition limits lean practic-es.	Negi et al., 2024	
DQQ43	CQQ43	Absence of performance evalua-tion	Moradi & Sormunen, 2023	
DQQ44	CQQ44	Unskilled workforce	Mossman, 2009	
DQQ45	CQQ45	Insufficient training in lean de-sign and construction	Negi et al., 2024	
DQQ46	CQQ46	Shortage of appropriate lean tools	Negi et al., 2024	
DQQ47	CQQ47	Insufficient funding during con-struction	Moradi & Sormunen, 2023	
DQQ48	CQQ48	Complex subcontracting layers	Chaudhary et al., 2022	
DQQ49	CQQ49	Poor organisational support for lean	Negi et al., 2024	
DQQ50	CQQ50	Ineffective supervision and con-trol	Mossman, 2009	
DQQ51	CQQ51	Insufficient standardisation	Chaudhary et al., 2022	
DQQ52	CQQ52	Limited personal empow-erment	Moradi & Sormunen, 2023	
DQQ53	CQQ53	Poor program planning (sched-uling)	Mossman, 2009	

Source: Negi et al. (2024), Chaudhary & Raghav (2022), Gupta et al. (2020), Sarhan & Fox (2013), Mo-radi & Sormunen (2023)

construction process.

RESULTS

The research identified variables that serve as barriers to the adoption of lean design and construction, and questions were formulated to gather responses from design consultants and contractors. The responses were analysed using the exploratory factor analysis (EFA) technique (Statistical to determine the latent structure within the collected data, and later to group correlated variables into distinct factors (model for related factors) (Brown, 2015).

The hypotheses for the barriers to implementing lean design and construction were;

H_0 The observed barriers are uncorrelated and do not form any factors

H_1 The observed barriers are correlated and can be explained by the inherent factors

The EFA was conducted using principal component analysis (PCA) for extraction and varimax rotation with Kaiser Normalisation for the component factors. Varimax rotation was used because it assumes that the factors are uncorrelated (orthogonal) (Tucker & MacCallum, 1997). The research aims to simplify and interpret the complex data structure related to the collected variables (barriers). **Table 3** shows that the Kaiser-Meyer-Olkin (KMO) measure of sample adequacy was 0.685, indicating that the data are suitable for factor analysis. Bartlett's Test of Sphericity was significant ($p<0.05$), where the degrees of freedom X^2 (120) = 340.280. This supports the assumption for EFA for the analysis of factors in the correlation matrix. The null hypothesis was rejected, and the alternative hypothesis was that the observed barriers are correlated and can be used to explain the underlying factors.

The observed mean values in **Table 4** reveal that insufficient awareness (1.65) is the most important barrier to lean adoption according to contractors and design consultants. The highest mean value is 2.48 for the "competition limits lean practices" variable, indicating that respond-ents agree on the importance of this barrier to lean adoption/practice.

The table of communalities was used to knock off variables whose observed variances were less than 0.4. It is instructive that 80.2% of the variance in ineffective supervision and control is ac-counted for, 64.6% of the variance in insufficient awareness is accounted for, while 76.1% of the variance in resistance to change is accounted for. 61.8% of the variance in insufficient sup-port from senior management is accounted for. 70.8% and 75%

TABLE 3
KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.			0.685
Bartlett's Test of Sphericity	Approx. Chi-Square		340.280
	df		120
	Sig.		0.000

Source: Kioko, Masu & Rukwaro, 2025

TABLE 4
Descriptive statistics

Barrier	Mean Values
Insufficient Awareness	1.65
Resistance to change	1.76
Insufficient training in lean design and construction	1.78
Insufficient funding during construction (unpaid design fees)	1.87
Absence of performance evaluation for practising lean design	1.89
Poor organisational support for lean	2.02
Insufficient standardisation	2.04
Shortage of appropriate lean tools	2.06
Poor program planning (scheduling)	2.07
Challenges with cooperation	2.09
Insufficient support from senior leadership /management	2.15
Lack of relevant incentives	2.19
Ineffective supervision and control	2.19
Unskilled workforce	2.24
Complex subcontracting	2.43
Competition limits lean practices	2.48

Source: Kioko, Masu & Rukwaro, 2025

of the variances in challenges with cooperation and lack of relevant incentives, respectively, were accounted for (**Table 5**).

The variables were also analysed based on total variances and the Initial Eigenvalues and Extracted Sums of Squared Loadings noted. In this research, factors with Eigenvalues that are equal to or greater than one (1) were retained, and data interpretation was carried out (**Table 6**).

Table 6 shows that for component 1, the total value of extraction sums of squared loadings is 5.218>1, component 2 is 1.717>1, component 3 is 1.438>1, component 4 is 1.349>1, and component 5 is 1.052>1. Therefore, the stated set of 16 variables with 54 observations represents five (5) components. The extracted sums of squared loadings, which account for the per cent variance of the first factor, comprise 32.613% of the variance in the features from the observations. The second factor accounts for 10.734%, the third factor accounts for 8.988%, and the fourth and fifth factors account for 8.342% and 6.578%, respectively (**Table 6**). The five components (factors) cumulative percent of variances is 67.346% and this points to the fact that they are adequate (effective) enough in representing all the characteristics of the 16 variables (barriers).

Table 7 shows loadings of the sixteen (16) barriers on the five factors extracted. In this re-search, factor loadings less than 0.5 have been omitted to facilitate easier reading of the table. There is a presence of cross-loading on insufficient training in lean design and construction. Therefore, the rotated component matrix was used to identify the extracted factors.

The research employed varimax rotation to resolve the cross-loading challenge. As a result, a rotated component matrix was obtained, which involved calculating the rotated factor loadings, allowing for straightforward interpretation of the five factors. The five factors were then ana-lysed based on the variables in each group (**Table 8**).

Challenges with cooperation (0.670), unskilled workforce (0.627), complex subcontracting (0.632), ineffective supervision and control

TABLE 5
Communalities

Communalities		
	Ini-tial	Extrac-tion
Insufficient Awareness	1.000	0.646
Resistance to change	1.000	0.761
Insufficient support from senior leadership /management	1.000	0.618
Challenges with cooperation	1.000	0.708
Lack of relevant incentives	1.000	0.750
Competition limits lean practices	1.000	0.621
Absence of performance evaluation for practising lean de-sign	1.000	0.602
Unskilled workforce	1.000	0.514
Insufficient training in lean design and construction	1.000	0.683
Shortage of appropriate lean tools	1.000	0.735
Insufficient funding during construction (unpaid design fees)	1.000	0.755
Complex subcontracting	1.000	0.687
Poor organisational support for lean	1.000	0.489
Ineffective supervision and control	1.000	0.802
Insufficient standardisation	1.000	0.756
Poor program planning (scheduling)	1.000	0.649
Extraction Method: Principal Component Analysis.		

Source: Kioko, Masu & Rukwaro, 2025

TABLE 6
Total variance explained

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.218	32.613	32.613	5.218	32.613	32.613	3.496	21.849	21.849
2	1.717	10.734	43.347	1.717	10.734	43.347	2.705	16.908	38.757
3	1.438	8.988	52.335	1.438	8.988	52.335	1.998	12.487	51.243
4	1.349	8.432	60.768	1.349	8.432	60.768	1.404	8.775	60.018
5	1.052	6.578	67.346	1.052	6.578	67.346	1.172	7.327	67.346
6	0.997	6.231	73.577						
7	0.826	5.160	78.736						
8	0.633	3.955	82.691						
9	0.621	3.882	86.573						
10	0.523	3.270	89.843						
11	0.432	2.703	92.546						
12	0.421	2.631	95.177						
14	0.231	1.441	98.094						
15	0.174	1.090	99.184						
16	0.131	0.816	100.000						
Extraction Method: Principal Component Analysis.									

Source: Kioko, Masu & Rukwaro, 2025

TABLE 7
Component matrix

Component Matrix[a]					
	Component				
	1	2	3	4	5
Insufficient Awareness			0.591		
Resistance to change					0.778
Insufficient support from senior leadership /management	0.523				
Challenges with cooperation	0.742				
Lack of relevant incentives	0.686				
Competition limits lean practices				-0.583	
Absence of performance evaluation for practising lean design		0.617			
Unskilled workforce	0.595				
Insufficient training in lean design and construction	0.597	0.503			
Shortage of appropriate lean tools	0.658				
Insufficient funding during construction (unpaid design fees)				0.612	
Complex subcontracting	0.809				
Ineffective supervision and control	0.701				
Insufficient standardisation	0.537				
Poor program planning (scheduling)	0.690				

Source: Kioko, Masu & Rukwaro, 2025

TABLE 8
Rotated component matrix

Rotated Component Matrix[a]					
	Component				
	1	2	3	4	5
Insufficient Awareness			0.762		
Resistance to change					0.867
Insufficient support from senior leadership /management			0.697		
Challenges with cooperation	0.670				
Lack of relevant incentives				0.574	
Competition limits lean practices				0.735	
Absence of performance evaluation for practising lean design		0.709			
Unskilled workforce	0.627				
Insufficient training in lean design and construction		0.788			
Shortage of appropriate lean tools		0.790			
Insufficient funding during construction (unpaid design fees)				-0.641	
Complex subcontracting	0.632				
Ineffective supervision and control	0.886				
Insufficient standardisation		0.590			
Poor program planning (scheduling)	0.684				
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalisation.[a]					
a. Rotation converged in 6 iterations.					

Source: Kioko, Masu & Rukwaro, 2025

(0.886), and poor program planning (0.684) have significant positive loadings on factor 1. Therefore, the factor describes poor contract admin-istration as a leading barrier to the adoption of lean in design and construction.

The absence of performance evaluation for practising lean design (0.709), Insufficient training in lean design and construction (0.788), shortage of appropriate lean tools (0.790), and insufficient standardisation (0.590) have large positive loadings on factor 2. Thus, this factor describes a lack of lean culture in design and construction processes.

Insufficient awareness (0.762) and insufficient support from senior management (0.697) exhibit a marked positive loading on factor 3, which describes the leadership disconnect as a barrier.

Lack of relevant incentives (0.574), competition limits lean practices (0.735), and insufficient funding during design and construction have a positive loading on factor 4. Consequently, this factor encompasses the costs and market barriers associated with lean practice. Resistance to change (0.867) has a significant positive loading on factor 5, which describes employees' inertia in adopting lean practices in the design and construction sectors.

Data Interpretation

The barriers to adopting lean design and construction can be grouped into five major factors: poor contract administration, lack of lean culture, leadership disconnect, cost and market barri-ers, and employees' inertia. The primary barriers to adopting lean are attributed to the inefficient management of contractual responsibilities, from project inception to handover. Poor contract administration has a negative impact on clients, contractors, subcontractors, and design consultants. The consequences include increased costs due to unbudgeted changes and financial losses arising from liquidated damages or missed opportunities to generate revenue from the completed project by the clients. Other negative consequences are project delays, often seen in uncompleted tasks, rework (activities delayed as remedial work is done), and certain disputes that usually halt projects until they are resolved. Poor contract administration is evident in deviations from the original design, particularly when specifications are not adhered to, resulting in substandard work.

A lack of lean culture was identified as a barrier to adopting lean practices in design and con-struction phases. Lean design begins with a client brief that underscores value maximisation (quality and time goals met at the lowest cost possible). When lean is not built into the process and people are trained to practice lean, waste is built into the design and construction processes due to the siloed operations of different design professions (Isa, 2017). The latter is marked by poor communication and collaboration, and reactive problem-solving ensues from these discon-nected teams (costly and often with delays). A lack of top management support amplifies the struggle of employees as they attempt to implement lean practices in their tasks. These can be attributed to insufficient training at all levels of the organisation, perhaps due to the high cost of training and the attendant lean practice software. Therefore, cost and market barriers are noted as major impediments to introducing and practising lean in the design and construction process-es. This is often seen in the resistance to change from familiar traditional approaches to design and construction, where the primary focus is on each distinct profession in the design or trades during the construction phase (Larsson, 2013).

CONCLUSION

The successful adoption of lean design and construction is significantly hampered by five interconnected barriers: poor contract administration, the absence of a lean culture, a disconnect with leadership, prohibitive costs, and employee resistance to change. The most critical of these are inefficient contract management, which leads to project delays, cost overruns, disputes, and substandard work. This issue is compounded by a lack of a collaborative lean culture, where siloed operations, poor communication, and insufficient top-level support prevent the effective implementation of lean principles, ultimately embedding waste into the project lifecycle (Sarhan & Fox, 2013).

RECOMMENDATIONS

This study recommends a new contract management system to prevent delays, disputes, and expensive rework. This system will clearly define responsibilities, ensure specifications are followed from start to finish, and simplify the change management process. Adopting this system is part of a wider shift towards a lean culture, which focuses on maximising value and reducing waste. Success depends on breaking down professional silos and fostering collaboration among clients, designers, and contractors from the project's inception.

However, none of this is possible without strong leadership commitment to the lean agenda. Top management must champion the change by allocating the necessary resources, driving the required cultural shift, and consistently investing in training and technology to support the team.

To overcome cost and knowledge barriers, leadership must invest in comprehensive training on lean principles for everyone, from management to tradespeople. This training must include hands-on instruction with relevant software to give teams the practical tools they need.

To sustain this new culture, it's crucial to manage employee resistance to change. This means clearly communicating the benefits of lean methods over traditional ones. Demonstrating how these practices improve efficiency, cut waste, and create better project outcomes will encourage buy-in. Collaborating with industry leaders and sharing best practices will also be essential for helping teams adopt and maintain these new principles.

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