

# LEAN TECHNIQUES FOR PROJECT DELIVERY: ASSESSING CONSTRUCTION PROFESSIONALS' LEVEL OF AWARENESS

Matthew Ikuabe<sup>1</sup>, Douglas Aghimien<sup>2</sup>, Clinton Aigbavboa<sup>3</sup>, Ayodeji Oke<sup>4</sup>, and Pretty Ramaru<sup>5</sup>

## ABSTRACT

*Evidence from practice and literature indicates that the South African construction industry faces various challenges. Notably, the traditional methodologies deployed for project delivery continues failing to attain projects' objectives. Lean construction promotes developing and accomplishing construction projects within its envisaged goals by deploying targeted tools/techniques. Considering the glaring comparative advantage of deploying lean concepts in construction activities, this study assesses the level of awareness of lean techniques among professionals in the South African construction industry. The study adopted a quantitative approach aided by using a well-structured questionnaire that elicited responses from the target respondents. Data analysis methods employed are descriptive and inferential statistics. The study's findings showed that total quality management, waste elimination, and prefabrication are the most known lean techniques among South African construction professionals. Besides, findings indicated that there is a statistically significant disparity in the knowledge of lean techniques among the professionals in the South African construction industry. Conclusively, the study proffered recommendations that would aid in boosting the awareness and knowledge base of the various lean techniques among professionals for better construction delivery.*

**Keywords:** Awareness; Construction Professionals; Lean Construction; Lean Techniques; South Africa.

## 1. INTRODUCTION

The construction industry plays a vital role in any country's national economy and economic improvement; however, there is a significant variation in these roles among various countries. For both developing and developed nations, the construction business

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<sup>1</sup> Senior Lecturer, School of Construction Economics and Management, University of the Witwatersrand, South Africa, [matthew.ikuabe@wits.ac.za](mailto:matthew.ikuabe@wits.ac.za)

<sup>2</sup> Senior Lecturer, School of Art, Design and Architecture, Faculty of Arts, Design and Humanities, De Montfort University, UK, [aghimiendouglas@gmail.com](mailto:aghimiendouglas@gmail.com)

<sup>3</sup> Professor, SARChI in Sustainable Construction Management and Leadership in the Built Environment, Faculty of Engineering and the Built Environment, University of Johannesburg, Johannesburg, South Africa, [caigbavboa@uj.ac.za](mailto:caigbavboa@uj.ac.za)

<sup>4</sup> Associate Professor, Department of Quantity Surveying, Federal University of Technology, Akure, Nigeria, [emayok@gmail.com](mailto:emayok@gmail.com)

<sup>5</sup> Department of Construction Management and Quantity Surveying, University of Johannesburg, South Africa, [dpramaru@gmail.com](mailto:dpramaru@gmail.com)

serves as a critical segment in the establishment of the Gross Domestic Product (GDP) through the use of a segment of the populace, making a sizeable section capital formation and integrates firmly with other sectors (Ikuabe et al., 2021). In addition, Otasowie et al. (2024) indicates that the construction industry of developing countries aids in providing infrastructure such as public utilities spanning housing, schools, roads, railways, hospitals, airports, and other related infrastructure. Over time, the construction sector has been attributed to having an array of challenges plaguing its effective delivery of projects. These challenges cover issues like cost overrun, delays in project delivery, safety problems, and undesired quality (Akinshipe et al., 2024). A significant number of projects are characterised by delay in completion, costs overruns, sub-standard delivery, and often times requiring re-work. Aghimien et al. (2021) noted that many projects are not achieving the required performance regardless of the significant expense of advancement and the input of recent techniques.

The Lean Concept (LC) is projected as a viable model for project managers seeking to challenge the conventional concept of construction and project management (Ikuabe et al., 2022). The lean concept is defined as a “technique to plan creation frameworks to limit the waste of resources, time, and effort, bearing in mind the end goal to yield the greatest imaginable amount of major cost” (Mossman, 2009 p.4). According to Johansen and Walter (2007), applying lean practice to construction processes is exceptionally restricted and slow. Results from countries that have implemented lean concepts suggest great rewards, however, others are still lagging due to certain factors. One notable reason is the shallow knowledge-base of the concept among industry’s stakeholders (Mossman, 2009). Moreover, Olatunji (2008) asserted that Nigeria's construction professionals' level of awareness of lean concepts is shallow. The same can be said for other developing countries. Furthermore, Aigbavboa et al. (2016) affirmed that there are several limits to the promotion of lean concepts in the processes making up the execution of construction projects. Thus, hindering the numerous overwhelming advantages of its uptake in the value chain of construction project execution. Based on those mentioned earlier, this study is propelled towards ascertaining the level of awareness of lean techniques deployed for project execution within the South African construction industry to proffering recommendations on enhancing the knowledge base of lean techniques for enhanced construction project delivery.

## **2. THEORETICAL BACKGROUND**

Lean techniques serve as the spine of lean concepts in construction, and they seek to mitigate some of the inherent challenges peculiar to the construction industry. According to Kumar et al. (2022), lean techniques are approaches, procedures, systems, concepts, frameworks, and procedures whose application aids organisations in the execution of lean tasks execution. Lean concepts are typified by a variety of lean techniques that aid in the propagation of lean construction. These include Kanban (Pull system), a Japanese word translated as signboard or billboard (Sarhan et al., 2017). This lean technique is deployed to monitor the volume or quantity of apparatuses or materials (Memon et al., 2010). Increased visualisation is deployed as a lean technique for construction project delivery. This approach aids in creating a harmless, easy, and transparent process for all stakeholders on-site (Bajjou et al., 2017). Work standardisation is a lean technique attributed to a set of methods, mechanisms, or strategies which portrays consistency or replication of effective practices termed standard operating strategies (Ullah et al., 2016).

Furthermore, prefabrication is a lean technique that entails using manufactured and modularised construction tools to solve construction-related issues encountered on-site (Thaís da et al., 2012). Al Sehami et al. (2014) state that the Last Planner System is a lean technique that is a cooperative preparation approach that makes a usual design through the expansion of the guarantee of work trades development. This approach is reflected as an engaged mechanism whose aim is to regulate workflow and reduce the instability in construction projects.

Value stream mapping is a lean technique targeted at improving the flow of a process by highlighting opportunities for improvement. It is used in upscaling value flow (Yu et al., 2009). This approach aids in the reduction of waste by targeting the causes such as overproduction, relocation, and waiting for inventory. Moreover, waste elimination is a lean technique whose strategy aims to target the causes of waste in project execution (Zhang et al., 2017). This technique is focused on quality defects, relocations, inventory, overproduction, and overprocessing. The Kaizen (Continuous Improvement) lean technique is derived from a Japanese philosophy based on continuous improvement (Sarhan et al., 2017). This technique aims to create an environment whereby there is the assignment of responsibilities to individual workers who are motivated to identify lapses in the delivery chain for efficiency (Sarhan et al., 2017). Furthermore, Total Quality Management (TQM) is applied as a lean technique as a management method that targets the incorporation of all organisational purposes for the attainment of clients' needs and execution targets (Ullah et al., 2017). This technique utilises a fusion of statistical process control and problem-solving teams for the advancement of procedural abilities. Further, using the Five Whys as a lean technique is based on the drive for problem-solving through recognising foundation sources of targeted issues in project delivery (Sarhan et al., 2017). The First-run study is a technique whose implementation process is conducted in four stages. These stages are categorised as plan, do, check, and act (Bajjou et al., 2017). This technique is primarily deployed in redesigning basic projects and auditing work strategies through re-designing and streamlining the unique capability adopted.

### **3. METHODOLOGY**

The study's aim is to appraise the level of awareness of lean techniques among professionals in the built environment in South Africa. Adopting a post-positivism philosophical approach, the study utilised a quantitative method to get data from the target respondents. This was employed to get a wide range of respondents' viewpoints on their awareness of lean construction. These target respondents were construction professionals namely, construction project managers, quantity surveyors, construction managers, architects, and engineers. These professionals were selected because they comprise the critical stakeholders in construction project delivery. A questionnaire was used for the collection of responses from the study's target respondents due to its relative advantage of providing data in a short time frame (Tan, 2011). The questionnaire enquired on the rating of the awareness of the identified lean techniques by the respondents. The employed sampling procedure for the study was convenience sampling due to the limited time frame for the conduct of the research, and this led to the acquisition of 152 questionnaires from the respondents that were suitable for analysis. Mean Item Score (MIS) was used for the ranking of the lean techniques; Kruskal Wallis *h*-test (K-W) was used to ascertain if there was a difference in the respondents' responses regarding their awareness of the identified lean techniques based on their professional designation. The

Student Newman Kauls (SNK) post hoc test was used to differentiate the mean responses of the categorised respondents based on their professional affiliation. Furthermore, using the Cronbach’s alpha test, the validity and reliability of the questionnaire was established. The analysis gave an alpha value of 0.811, which indicates good validity and reliability since it is above the threshold of 0.7 and closer to 1.0 (Tavakol & Dennick, 2011).

#### 4. FINDINGS AND DISCUSSION

##### 4.1 LEVEL OF AWARENESS OF LEAN TECHNIQUES

The study respondents conducted the awareness rating of the identified lean techniques and subsequently analysed them. Firstly, as portrayed in Table 1, the result of the MIS conducted shows that the lean technique that is well known among the construction professionals in South Africa is total quality management with a mean score of 3.77, this is followed by waste elimination which is a mean score of 3.36, then followed by prefabrication with a mean score of 3.36.

Table 1: Lean techniques awareness level

Lean Techniques	$\bar{X}$	R	K-W	
			$X^2$	Sig.
Total quality management (TQM)	3.77	1	9.679	0.714
Waste elimination	3.36	2	3.297	0.593
Prefabrication	3.34	2	2.116	0.339
Standardization	3.31	4	7.024	0.813
First run studies (plan, do, check, and act)	3.22	5	7.936	0.062
Amplified visualisations	3.15	6	2.195	0.021**
5s process (Sort, Set in order, Shine, Standardize, and Sustain)	3.14	7	5.902	0.109
Value stream mapping (VSM)	3.10	8	2.118	0.783
Kaizen	3.04	9	3.274	0.091
Five whys	3.02	9	1.482	0.041**
Just-in-time (JIT)	2.99	11	5.228	0.115
Error proofing /fail-safe for quality and safety (Poka-yoke)	2.91	12	7.218	0.072
Last planner system	2.88	13	6.812	0.592
Ishikawa diagram	2.85	14	8.224	0.002**
Failure mode, effects, and criticality analysis (FMECA)	2.83	15	6.162	0.228

The fourth-ranked lean technique is standardisation, with a mean score of 3.31, while the fifth-ranked lean technique is first-run studies, with a mean score of 3.22. The least ranked lean techniques are failure mode, effects, and criticality analysis, with a mean score of 2.83 and the Ishikawa diagram, with a mean score of 2.85. Secondly, the data was subjected to the *K-W test to ascertain if there was a statistical difference in the opinions given by the respondents based on their professional designation. The result shows no significant difference based on the respondents’ professional affiliation responses for*

twelve of the lean techniques. These lean techniques had a *p*-value above 0.05. This implies that there is a convergent opinion among the different professionals based on their opinions on the level of awareness of the twelve lean techniques. Besides, it is shown that there is a divergent opinion for three of the lean techniques. These lean techniques have a *p*-value less than 0.05, thus indicating a significant difference in the opinions of the respondents based on their professional designation. The three lean techniques are increased visualisation, five whys, and the Ishikawa diagram.

Table 2 portrays the findings of the conducted analysis of the multiple comparisons test (SNK post hoc test).

*Table 2: SNK post hoc test*

Groups	N	Subset for alpha=0.05	
		1	2
Architects	15	2.8115	
Engineers	15	2.9278	
Construction Managers	15		3.1835
Construction Project Managers	15		3.2891
Quantity Surveyors	15		3.5679
<i>Sig.</i>		1.000	.325

The result shows that there is a difference in opinion of the level of awareness of the identified lean techniques among the two groups of professional designations. The first group comprises architects and engineers with corresponding values of 2.8115 and 2.9278 respectively. The second group is constituted of quantity surveyors, construction project managers, and construction managers, with their corresponding values of 3.5679, 3.2891, and 3.1835, respectively.

#### **4.2 DISCUSSION OF FINDINGS**

In support of the outcome of this study, Sarhan et al. (2017) noted that there is a seeming progressive awareness of lean techniques in the construction sector. Furthermore, the study corroborates the findings of Johansen and Walter (2007), who opined that there is a growing level of awareness of the applicability of lean concepts in the delivery of construction projects. This has mainly been influenced by establishing a couple of LC Consultants, the Lean Construction Institute, and publicity companies. Furthermore, lean construction education is now being offered by some universities and organisations, which has helped strengthen the general awareness level of the phenomenon. Overall, the findings from the study indicate that there is a moderate level of awareness of the lean concept among construction professionals in South Africa. Respondents asserted that the lean techniques with the highest level of awareness in the South African construction industry are total quality management, waste elimination, and prefabrication. This might not be unconnected with the growing drive to deliver construction projects that align with construction organisations' core mandates. Therefore, it is not quite far off from the tent of total quality management, which is applied as a lean technique as a management method that targets the incorporation of all organisational purposes for the attainment of clients' needs and execution targets (Ullah et al., 2017). Furthermore, the optimisation of construction processes through the enhancement of material utilisation is fast gaining

momentum among construction organisations. This is in tandem with waste elimination, a lean technique whose strategy is aimed at targeting the causes of waste in project executions (Zhang et al., 2017). Moreover, findings show that architects and engineers have similar views on the awareness level of lean techniques, while construction managers, quantity surveyors, and construction project managers all have similar opinions on the subject matter. This might be related to their roles in the delivery of construction projects.

## 5. CONCLUSIONS AND RECOMMENDATIONS

An assessment of the awareness level of lean techniques among professionals within the South African construction space was conducted by the study. Findings showcased that the lean techniques most known by these professionals are total quality management, waste elimination, and prefabrication, which are techniques deployed in delivering construction projects within the ambits of lean concepts. The findings showed that the empirical analysis of the study indicates a moderate level of the identified lean techniques. Hence, the recommendations put forward by the study states that the awareness and adoption of the principles and techniques of lean construction should be propagated among stakeholders and professionals in the industry. Relevant stakeholders are implored to help boost the implementation of lean concepts resulting from the inherent benefits therein. This should be encouraged against the unjustifiable project management approaches currently being utilised in the industry over the years, hence, being replaced by the lean concept approach. Furthermore, the government should prioritise investing in innovative ways of encouraging the uptake of lean techniques with the aid of technology. Cutting-edge research on lean construction needs to be encouraged to provide innovative ways for technological infusion in lean concepts for effective construction processes. It is worth noting that this research was limited to Gauteng province in South Africa.

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