

38 proper management of people, materials, tools, plant and equipment. The coordination
39 is implemented to realise efficiency and enhance quality in products. As previously
40 opined however, fatalities, injuries, time and cost overruns, defects, low productivity
41 and other problems still manifest in construction. It is evident that quality improvement
42 is needed in the construction industry.

43 According to Locatelli, Mancini, Gastaldo and Mazza [4], there are an alarming
44 number of projects failing to deliver on time or/and within budget or/and with a
45 satisfactory standard and still requires additional work and re-works. Traditional project
46 delivery and procurement methodology has evolved into an inherently inefficient and
47 adversarial process. In contrast, lean construction provides an approach that
48 significantly improves collaboration, innovation, delivery, control and quality in
49 projects [3]. Lean construction is based on fundamentals such as maximum value
50 generation, flows of activities, pull demand systems and perfection in execution at
51 every level of the project [5]. As such, lean construction concept has demonstrated
52 enough capacity to improve construction project[3]. Therefore, this study outlines how
53 lean construction practices could enhance quality in construction projects.

54 **2 Literature Review**

55 Quality is one of the critical factors in the success of construction projects. The quality
56 of construction projects can be regarded as the fulfilment of the project participant's
57 expectations or requirements [6]. Also, quality is seen as the degree to which a set of
58 inherent characteristics fulfils requirements. Inadequate quality in construction projects
59 is a common phenomenon in the world [1]. This then results in many cases of disputes
60 happening among clients, house owners and parties involved in construction (especially
61 contractors) [7].

62 According to Ashokkumar [6], limited time, lack of training policies, limited fund,
63 lack of communication, obsolete methods, and non-compliances are some of the
64 reasons for the pervasiveness of poor quality in construction. Generally, to improve the
65 quality of construction, means to incur additional cost on the projects, which may be
66 delayed. This in turn may result in unsatisfied clients and introduce different kinds of
67 waste in construction.

68 Lean construction has been successful in eliminating waste and improve quality
69 standard of construction projects. As such, it is considered as an idealized model, which
70 aims at improving the construction schedule and eliminate problems on construction
71 projects to provide a defect-free production [8]. According to Aziz and Hafez [5], lean
72 construction is a way to construct systems which minimize waste of materials, time,
73 and effort to generate the maximum value, it uses the same principles as lean production
74 to reduce waste, increase productivity and effectiveness in construction through
75 effective management.

76 The Lean Construction Institute defines the process of lean project management,
77 which leads to improved quality as follows [5]:

- 78 • Determine client requirements and design to meet them;
- 79 • Align design to quality, schedule, and budget limits;

- 80 • Manage the project by breaking it into pieces, estimating duration and resource
81 requirements for each piece, and then put the pieces in a logical order with
82 Critical Path Method (CPM);
- 83 • Assign or contract for each piece, give start notice and monitor each piece to
84 assure it meets safety, quality, schedule and cost standards;
- 85 • Coordinate using the master schedule and weekly meetings;
- 86 • Cost may be reduced by productivity improvement: Duration may be reduced
87 by speeding each piece or changing logic; and
- 88 • Quality and safety get better with inspection and enforcement.

89 **3 Research Methodology**

90 A quantitative research approach was adopted to conduct the empirical study based on
91 a survey research design. The survey research design was adopted as it provides an
92 accurate portrayal of the opinions and knowledge of an individual, group, or situation.
93 The survey made it possible to collect a large amount of data under the same
94 circumstances, making it easy to compare the information as it was easier to understand
95 and summarise [9].

96 The sample stratum of this study was limited to the following building professionals:
97 Construction Managers (CMs), Construction Project Managers (CPMs), Quantity
98 Surveyors (Qs), Building Contractors and Civil Engineers. This was done to ensure
99 that different perspectives of the built environment professionals were covered, which
100 gave breadth and depth to the study. The sampling technique was purposive in nature
101 in that the questionnaires were merely distributed to the relevant professionals.

102 A questionnaire (soft and hard copy) was created to capture the responses of
103 professionals in the industry. The soft copies were e-mailed to potential respondents
104 and hardcopies physically distributed. A total of 37 emails were sent and 15
105 questionnaires were physically distributed. This totalled 52 potential responses. 21
106 Responses were received with a response rate of 40.4%.

107 Data analysis was based on descriptive statistics. Specifically, simple percentages,
108 bar chart and mean score were used for the analysis.

109 **4 Results and Discussion**

110 **4.1 Demographic Information of the Respondents**

111 Table 1 illustrates the number and percentage of professionals who responded to the
112 questionnaires, with the highest being CMs at 29%, this is followed by the Qs and
113 Civil Engineers with 24% each. Project Managers were 14%, while the Building
114 Contractors were 9%.

115 Also, it important to capture the years of experience of the respondents. As such, the
116 results from the study indicate that majority of the respondents have worked in the
117 industry for five or more years. This by implication means that the respondents have
118 requisite experience to answer the questionnaire.

119 **Table 1.** Number and percentage of professionals who responded to the questionnaires

Respondents	Number	Percentage (%)
Project Managers	3	14
Construction Managers	6	29
Quantity Surveyors	5	24
Building Contractors	2	9
Civil Engineers	5	24

120 **4.2 Factors Impacting on Quality of Construction Projects**

121 In a bid to explore how lean construction practices could enhance the quality of
 122 construction projects, it is important to first consider the factors impacting on quality
 123 of construction projects. To this end, Table 2 illustrates the professionals' perceptions
 124 of factors that impact on the quality of construction projects in terms of percentage
 125 responses to a scale of 1 (minor) to 5 (major); and mean scores (MSs) ranging between
 126 a minimum value of 1.00 and a maximum value of 5.00 were computed for each factor.

127 **Table 2.** Factors impacting on quality

Factor	Response (%)		Minor.....Major					MS	Rank
	Unsure	Does not							
			1	2	3	4	5		
Effective communication	0.0	4.8	0.0	0.0	4.8	23.8	66.7	4.48	1
Specifying client requirements	0.0	9.5	0.0	0.0	9.5	33.3	47.6	4.10	2
Employee participation	4.8	4.8	0.0	0.0	14.3	33.3	42.9	4.00	3
Frequent site meetings	0.0	4.8	0.0	4.8	14.3	42.9	33.3	3.95	4
Increased visualisation (quality and safety signs)	0.0	4.8	0.0	4.8	19.1	38.1	33.3	3.90	5
Standardized processes	4.8	4.8	0.0	0.0	9.5	57.1	23.8	3.86	6
Stakeholder commitment	4.8	4.8	4.8	0.0	19.1	19.1	47.6	3.86	6
Continues improvement	0.0	4.8	0.0	0.0	19.1	38.1	33.3	3.81	7
Elimination of waste	0.0	9.5	4.8	4.8	19.1	33.3	28.6	3.57	8

128 According to the results in Table 2, most the respondents ranked “effective
 129 communication” as the highest (MS = 4.48). While “specifying client requirements”;
 130 “employee participation”; “frequent site meetings” and other factors were ranked from
 131 second to eighth respectively. One of the profound findings from the results is that all

132 the MSs are greater than 3.00 indicating that all the factors have almost major impact
 133 on the quality of construction projects. Majority of the factors are related to the lean
 134 construction practices, which by implication means the lean construction has a role to
 135 play regarding the quality of construction projects.

136 4.3 Awareness of Lean Construction Implementation in Construction Projects

137 It cannot be ascertained whether or not the respondents ‘officially’ aware the
 138 application of lean construction in construction projects. To this end, Table 3 illustrates
 139 that only 33% of the respondents aware that the lean construction concept is being
 140 implemented in construction projects. This value is low indicating that majority of the
 141 respondents are not aware of the implementation of lean construction principle.

142 **Table 3.** Respondents’ awareness of lean construction implementation

Response	Number	Percentage (%)
Yes	7	33
No	11	53
Unsure	3	14

143 4.4 Impact of Lean Construction on Project Performance Parameters

144 Indirectly, respondents were asked to rank, based on their perception, the impact of lean
 145 construction on project performance parameters. Table 4 illustrates the their
 146 perceptions on how lean construction impacts on the project parameters in terms of
 147 percentage responses on a scale of 1 (Minor) to 5 (Major), and MSs ranging between a
 148 minimum value of 1.00 and a maximum value of 5.00.

149 **Table 4.** Impact of lean construction on project performance parameters

Parameter	Response (%)							MS	Rank
	Unsure	Does not	Minor.....Major						
			1	2	3	4	5		
Time	4.8	0.0	0.0	4.8	9.5	23.8	57.1	4.24	1
Cost	4.8	0.0	4.8	0.0	4.8	38.1	47.6	4.14	2
Quality	9.5	4.8	0.0	4.8	0.0	28.6	52.4	4.00	3
productivity	14.3	0.0	0.0	4.8	4.8	33.3	42.9	3.86	4
Client satisfaction	4.8	4.8	4.8	9.5	14.3	19.1	42.9	3.67	5
Environment	19.1	0.0	0.0	4.8	19.1	14.3	42.9	3.57	6
Health and safety	19.1	0.0	0.0	19.1	4.8	9.5	47.6	3.48	7
Waste	9.5	14.3	0.0	4.8	19.1	19.1	33.3	3.3 3	8

Table 5. Lean Implementation statements

Statement	Response (%)						MS	Rank
	Unsure	Strongly disagree	Disagree	Neutral	Agree	Strongly agree		
A reduction of waste decrease the project costs	0.0	0.0	4.8	4.8	42.9	47.6	4.33	1
Worker participation leads to continues improvement	0.0	0.0	0.0	9.5	57.1	33.3	4.24	2
Daily site meetings help identify potential problems on the site.	4.8	0.0	0.0	4.8	47.6	42.9	4.19	3
The inclusion of the suppliers in the planning process promotes on time delivery materials to projects site	0.0	0.0	0.0	9.5	66.7	23.8	4.14	4
Considering customer feedback leads to continuous improvement	0.0	0.0	0.0	14.3	57.1	28.6	4.14	4
Specifying client requirements leads to improved quality	0.0	0.0	14.3	9.5	42.9	33.3	4.00	5
Employees willingness to learn new techniques leads to continuous improvement	0.0	0.0	9.5	9.5	57.1	23.8	3.95	6
More effort in planning, through the Last Planner System promotes a smooth workflow.	14.3	0.0	0.0	14.3	23.8	47.6	3.90	7
Making use of look ahead schedules increase the work flow	0.0	0.0	0.0	38.1	33.3	28.6	3.86	8
Defining end-to-end processes for a project helps establish processes that are efficient and waste-free	9.5	0.0	0.0	23.8	38.1	28.6	3.76	9
Posting signs on the site (safety and quality signs) makes workers and guests compliant with safety rules and regulations.	0.0	0.0	14.3	28.6	28.6	28.6	3.71	10
Training of the stakeholders helps eliminate resistance to change	0.0	0.0	4.8	33.3	42.9	14.3	3.57	11
The inclusion of suppliers in the planning process fosters the reduction of material lead times	0.0	9.5	14.3	9.5	47.6	19.1	3.52	12
Ordering materials just before they are required reduces inventory waste	0.0	0.0	23.8	23.8	42.9	9.5	3.38	13
More effort in planning, through the Last Planner technique decreases the variability in the process.	14.3	0.0	0.0	19.1	47.6	14.3	3.33	14
Including customers during project definition and design phase leads to waste reduction.	0.0	4.8	33.3	28.6	19.1	14.3	3.05	15
Reduction in non-value adding activities reduces waste	14.3	0.0	14.3	33.3	28.6	9.5	3.05	15

151 It is noticeable that all of the MSs are above 3.00, which implies that the that the
152 professionals perceived that lean construction has a major impact on these project
153 performance parameters as opposed to a minor impact.

154 **4.5 Lean Construction Implementation**

155 Table 5 illustrates the respondents' perception regarding how lean tool/techniques
156 needs to be implemented in construction (based on the various lean implementation
157 statements) in terms of percentage responses to a scale of 1 (minor) to 5 (major); and
158 MSs ranging between a minimum value of 1.00 and a maximum value of 5.00.

159 It is also noticeable that all the following statements MSs are higher than the midpoint
160 of 3.00, which indicates that the respondents are deemed to agree as opposed to disagree
161 with these statements. By implication, it means that lean tool/techniques are inevitable
162 in construction projects.

163 **5 Discussion**

164 The findings from the study indicates that the factors identified have almost major
165 impact on the quality of construction projects. One thing that is evident from the study
166 is that majority of the factors are related to lean construction practices, which by
167 implication means the lean construction has a role to play regarding the quality of
168 construction projects. This is in consonance with the process of lean construction
169 project management, which actually leads to improved quality [5].

170 Majority of the respondents are not aware of the implementation of lean construction
171 principle. As such, this is capable of impeding on the acceptance and hence the
172 implementation of the concept for construction projects. Additionally, the professionals
173 were of the opinion that lean construction has a major impact on project performance
174 parameters. As such, the lean tool/techniques are inevitable in construction projects.

175 **6 Conclusions**

176 This study outlined how the lean construction principle can improve quality of
177 construction projects. From the study, it is evidence that there are many factors
178 impacting on the quality of construction projects of which majority of those factors are
179 related to lean construction. Lean construction not only focuses on improving the
180 quality of project but also aims to reduce the time involved, eliminate failure and
181 eliminate waste in construction. There are different types of lean tools/techniques that
182 can be used in the construction industry based on the lean implementation statements
183 that were assessed. However, the awareness level of the respondents regarding the
184 application of lean construction principle in construction projects is limited in the study
185 area. As such, many of the industry professionals in the Eastern Cape Province of South
186 Africa are unaware of lean or know how to implement it.

187 It is recommended that lean construction should not only be adopted into
188 construction projects as an alternative to traditional construction or when requested by
189 clients. It should become part of the organisations culture, goals and objective if
190 organisations wish to strive for improved quality and performance. For professionals to
191 experience the maximum benefits of lean construction and for lean construction to be
192 successful, professionals need to follow the lean process and the statements as outlined.
193 They also need to implement the correct lean tool/technique to improve a specific
194 project parameter or the overall project performance.

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