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Barriers to Sustainable Implementation of Lean Construction in the Ghanaian Building Industry

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ABSTRACT

Purpose: Adoption of lean construction in the construction industry will improve quality and efficiency, eliminate waste and increase value for the client. It is a production-based management strategy that enables construction companies to maximize profits by maximizing efficiency and eliminating waste of resources. Lean production efforts in some countries have not been successful due to the many barriers to its successful implementation. This study was undertaken to identify possible barriers to successful and sustainable implementation of lean construction in the Ghanaian building industry and possible measures to overcome such barriers.

Design/Methodology/Approach: A **s**tructured questionnaire survey of 400 technical managers of construction organizations was carried out to identify possible barriers to implementation of lean construction and possible measures to overcome them in Ghana. Factor analysis using SPSS version 16 package was adopted to group the barriers identified. Measures identified were evaluated based on mean scores and ranked according to their strengths.

Findings: **D**ifficulty in understanding lean concepts, inconsistency in government policies, poor project definition, incomplete designs, lack of standardization and lack of long term relationship with suppliers were some of the barriers identified and grouped into Managerial, Technical and Teamwork issues.

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Research Limitations/Implications: The study should have covered all categories of contractors but due to lack of reliable information on the large number of small scale construction organizations, only large scale firms were studied.

Practical Implication: The paper provides possible barriers to the implementation of lean construction and possible measures to overcome such barriers in building projects to improve construction quality and efficiency.

Originality/Value: Identification of potential barriers and possible measure to overcome them are steps towards successful implementation of the lean concept in the Ghanaian building industry.

Keywords: Lean construction, barriers, building industry, Ghana

1. INTRODUCTION

The building industry is often described as an industry with many problems and lack of efficiency (Alinaitwe, 2009; Kpamma, 2009). Several researchers have expressed concern about the continued decline in performance of the construction industry and the increasing challenges facing the industry (Alinaitwe, 2009; Seranatne and Wijesini, 2008; Beathan *et al.*, 2004; Yasamis *et al.*, 2002; Anumba et al*.,* 2002; Abdulhadi, 1997). To deal with this situation, some construction companies have adopted Total Quality Management (TQM) system and others have tried rightsizing, restructuring and other concepts in order to reverse the trend (Alinaitwe, 2009; Abdul-Hadi et al., 2005). The solution to this problem is said to be in using the concept of lean construction (LC) (Alinaitwe, 2009; Seranatne and Wijesini, 2008). The word lean is defined as "give customers what they want, deliver it instantly with no waste" (Howell, 2001). Lean production is currently a buzzword in many manufacturing industries and some organizations in the construction sector have tried to adopt it (Fellows *et al.*, 2002). The proponents of LC argue that it has the potential to tap into new and existing production theories dedicated to minimizing wasteful activities. LC has the goal of better meeting customers' needs while minimizing waste and using fewer resources (Alinaitwe, 2009; Dunlop and Smith, 2004). LC concepts have recently received attention as a modern way to improve construction performance and labor productivity (Abdel-Razek *et al.,* 2007). It is one of the latest management concepts which advocates for minimizing waste in the construction process; a change the construction industry needs (Alinaitwe, 2009).

The LC concept has been introduced in the construction industry in various countries such as Australia, Brazil, Denmark, Ecuador, Finland, Peru, Singapore, United Kingdom, United States of America and Venezuela (Abdullah *et al.*,2009; Johansen and Walter, 2007; Ballard and Howell, 2004), and its application within the industry is reported to have resulted in a lot of benefits. This is so because its approach is different from the normal practices within the construction process as it is based on production management principles. LC also has better results in complex, uncertain and quick projects (Salem *et al.*, 2005). The following benefits are claimed for its implementation in the construction industries of many emerging economies (Mossman, 2009; Lehman and Reiser, 2004):

- more satisfied clients,
- productivity gains,
- greater predictability,
- shorter construction periods
- improved design
- reduced cost and less waste.

In spite of these benefits, the construction industry has generally been slow in taking up lean concepts (Johansen and Walter, 2007; Johansen *et al.*, 2002; Common *et al., 2000*).

There are a number of factors that affect the construction industry in Ghana. The industry experiences problems of increased cost of production, delays in delivering construction products and services, incidence of waste associated with production, poor design quality, personnel issues and financial problem such as cancellation of advance mobilization, cumbersome payment process, limited access to credit and lack of adequate equipment holdings (Laryea and Mensah, 2010). The application of the LC concept in the Ghanaian construction industry is still considered a new approach.

Review of lean construction and barriers to its implementation

The traditional construction system is mainly project-based and characterized by one-of-a kind set-ups (Hook and Stehn, 2008; Vrijhoef and Koskela, 2005). The capability and efficiency of the construction sector need to be improved to modernize the sector and eventually increase user satisfaction (Alinaitwe, 2009). The various parties in the construction sector have undertaken numerous approaches to assist in establishing methods which are believed to be able to improve and subsequently increase the efficiency and effectiveness of the sector (Cohen, 2010; Alinaitwe, 2009; Mastroianni and Adelhamid, 2003).

LC is a way to design production systems to minimize waste of materials, time and effort in order to generate the maximum possible amount of value (Koskela et al., 2004; Koskela and Howell, 2002). It is also a holistic design and delivery philosophy with an overarching aim of maximizing value to all stakeholders through systematic, synergistic and continuous improvements in the contractual arrangements, product design and method of selection, the supply chain and the workflow reliability of site operations (Abdelhamid, 2004). At the Design for Manufacture Competition (2005), LC was defined as the continuous process of eliminating waste, meeting or exceeding all customer requirements, focusing on the entire value stream and the pursuit of perfection in the execution of a project. In the opinion of Mossman (2009), lean thinking is lean because it provides a way to do more and more with less and less – less human effort, less

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equipment, less time and less space – while coming closer and closer to providing customers with exactly what they want.

The building industry has a large number of specialized areas and disciplines, and many are based on cyclic processes. Proponents of lean construction argue that it is possible to identify the wasteful activities in the processes and make concessions for them, leading to better understanding and improvement in overall performance (Alinaitwe, 2009; Dunlop and Smith, 2004).

LC consists of a series of flow conversion activities (Alinaitwe, 2009). Conversion activities are those operations performed when adding value to the material or when information is being transformed into a product, and flow represents tasks like inspections, waiting, moving and storing (Alinaitwe, 2009). Harris et al. (2005) also define lean construction as a concept that incorporates several other concepts from the construction management industry such as Total Quality Management (TQM), Last Planner System (LPS), Business Process Re-engineering (BPR), Concurrent Engineering (CE), Product Circles (PCs) and Team and Value Based Management. In the opinion of Alinaitwe (2009), most of these concepts (Figure 1) are interrelated and all aim to improve performance while minimizing waste.

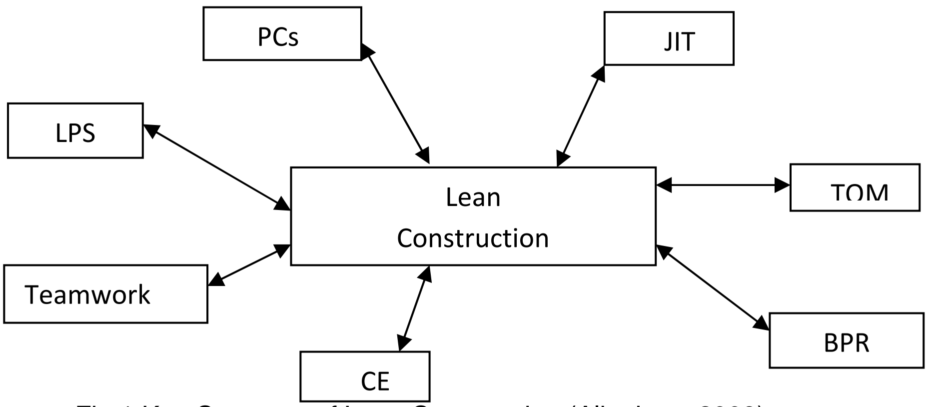

Fig 1 Key Concepts of Lean Construction (Alinaitwe, 2009)

As with implementation of other methods or approaches aimed at increasing the performance of the construction sector, the application process of lean principles is sure to encounter various obstacles. Research findings of the Production Management Center (GEPUC) of the Catholic University of Chile, has shown that the application of the LC concept in the industry has faced problems pertaining to time, training, organizational aspects and lack of self-criticism (Alarcon *et al.*, 2008). Furthermore, a major problem with the application of lean construction concept involves aspects of attitude, internal relationships and co-operation. The obstacles

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within these aspects are related to lack of organizational culture supporting teamwork, lack of group culture, shared vision and shared consensus, inadequate knowledge and skills etc. (Castka *et al.*, 2004; Cua *et al.*, 2001; Conte and Gransberg, 2001).

There are various barriers to efforts aimed at sustainable implementation of the LC concept. Forty barriers to the implementation of lean construction and seventeen measures to overcome them were identified from literature (Bashir *et al.*, 2010; Abdullah *et al.*, 2009; Alinaitwe, 2009; Mossman, 2009; Jorgensen and Emmitt, 2008; Olutanji, 2008; Salem *et al.*, 2005; Forbes and Ahmed, 2004; Castka *et al.*, 2004; Alarcon et al., 2002; Cua *et al.*, 2001; Common *et al.*, 2000). These barriers refer to attitude, roles, relationships, actions and communications among the respective parties involved in the construction industry such as contractors, sub-contractors as well as the client (Forbes and Ahmed, 2004). In the Ugandan construction industry, thirty-one factors were identified as barriers to successful implementation of LC (Alinaitwe 2009), out of which ten were considered easy to overcome. The barriers identified by Alinaitwe (2009) include lack of keeping items in the right places, lack of buildable designs, lack of a participative management style for the workforce, not using standard components, lack of communication within teams, lack of steady work engagement, lack of understanding of customer needs, lack of project team skill and lack of well-defined focus for the team. Kpamma (2009) studied the practice of lean thinking at the pre-contract stage of building construction projects by selected Ghanaian firms. The objectives of Kpamma's research among others included identification of the extent of practice of lean thinking and the limitations to the practice of lean construction in Ghana. Inadequate familiarity of the construction firms with the concept of lean thinking was among a number of limitations identified in the possible application of the concept in the Ghanaian construction industry.

Although the factors identified from literature seem relevant to the Ghanaian situation, little has been done to assess how they apply in Ghanaian construction projects. By identifying and prioritizing barriers to LC on the basis of their influence and ease of overcoming them, building organizations can undertake waste minimization efforts with confidence and manage the various barriers with success.

The main objective of this study is to identify and prioritize influential barriers to successful implementation of LC in the Ghanaian construction industry and recommend measures to overcome such barriers.

2. RESEARCH METHODOLOGY

To identify and prioritize influential barriers to successful implementation of LC in the Ghanaian construction industry, a thorough review of the literature was conducted. Forty barriers and seventeen measures to overcome them were identified (Bashir *et al.*, 2010; Abdullah *et al.*, 2009; Alinaitwe, 2009; Mossman, 2009; Jorgensen and Emmitt, 2008; Olutanji, 2008; Salem *et al.*, 2005; Forbes and Ahmed, 2004; Castka *et al.*, 2004; Alarcon et al., 2002; Cua *et al.*, 2001; Common *et al.*, 2000). Since the barriers and measures gathered from the literature had been sufficiently tested and used in similar studies in other countries, they were used as basis for the present study.

A multiple research approach involving semi-structured interviews and a questionnaire survey was adopted for the study. Interviews were carried out prior to the questionnaire survey to examine the relevance of the identified factors in the Ghanaian context. Chief executives of building construction organization who are registered with the Ministry of Water Resource, Works and Housing (MWRWH) were involved in the study. Building construction organizations operating within Ghana register with the MWRWH. The Ministry has four categories of companies: D, K, E and G, based on the nature of work the organizations engage in - building, civil engineering, electrical and plumbing works respectively. There are four financial sub-classifications within these categories - Class 1, 2, 3 and 4 - which set the limitations for companies in respect of their asset, plant and labour holdings, and the nature and size of the projects they can undertake. Class 1 has the highest resource base, decreasing through classes 2 and 3, with class 4 having the least resource base (MWRWH, 2011).

The semi-structured interviews were conducted with five executive directors of D1/D2 firms operating in Kumasi and five academics who currently work with D1/D2 firms as project managers. The interviews led to the confirmation of 33 barriers and all the seventeen measures identified from the literature as relevant to the implementation of lean construction in Ghana. These factors were further investigated in the questionnaire survey. The survey targeted classes D1 and D2 building firms as well as consultants from quantity surveying and architectural firms fully registered with the Ghana Institution of Surveyors (GhIS) and the Architects Registration Council of Ghana (ARCG) respectively. The choice of D1/D2 firms was due to lack of reliable information on small scale firms, and also based on the assumption that large and well-established firms have good organizational set up and are more capable of undertaking lean production efforts. The records of the MWRWH (2011) indicate that there are 519 D1 and D2 construction organizations in the Ashanti and Greater Accra Regions of Ghana. Available records indicated that the ARCG had 114 architectural firms (ARCG, 2010), and the GhIS had 60 quantity surveying firms (GhIS, 2010) in Kumasi and Accra.

A sample size of 226 site managers of D1/D2 construction organizations was determined using the following formula recommended for such studies by Israel (1992).

$$n = \frac{N}{1 + N(e)^2}$$

where n is the sample size, N is the population size and e is the desired level of precision (±5%). A simple random sampling approach was used to select the 226 D1 and D2 firms.

Closed-ended questions were mainly prepared but options were given for respondents to add to the list of possible answers. The respondents were asked to score the severity of the 33 potential barriers to the implementation of lean construction on the Likert scale of 1-5 where 1= 'Not severe' and 5= 'Very severe'. Seventeen measures to overcome these barriers were also scored on a scale of 1-5, where 1= 'Highly unimportant' and 5= 'Highly important'. Each questionnaire was administered through a face-to-face session which ensured that 188 questionnaires out of the 226 were returned complete and used in the analysis, representing a response rate of 83%. All the 114 architectural firms and 60 quantity surveying firms fully registered with their professional institutions were covered in the study. Out of the 174 questionnaires sent to the consultants, 124 were completed, representing a response rate of 71%.

Data gathered was subjected to factor analysis using SPSS version 16 package. Factor analysis is a statistical technique used to identify a relatively small number of factors that explain observed correlations among variables (Marija, 2003). It is primarily used for data reduction or structure detection with the assumptions that the variables are continuous, normally distributed, have a good linear relation between them and have underlying factors responsible for the observed correlation. Factor analysis is used when people have been measured on several continuous variables and it is wished to see whether these variables can be reduced to a smaller set of variables (Chris 2004). It can also be used to identify any set of variables that correlate well with each other but less well with other items. It can be used to reduce a large number of correlated variables to a more manageable number of independent factors that can then be used in subsequent analysis (Marija 2003).

3. RESULTS AND DISCUSSIONS

Barriers to implementation of LC

Table 24.1 presents the results of the factor analysis carried out on the potential barriers to implementation of LC. A factor is deemed to be significant to the study if it has a mean value of 2.50 or more (Field, 2005). All the 33 factors have mean rating 2.50 or higher and were included in the factor analysis. All the 33 factors had communalities of 1.00, indicating their suitability for the factor analysis. The 33 significant factors were further reduced to common factor patterns. This was done to empirically explain the potential barriers to the implementation of LC in the Ghanaian construction industry. In doing this, principal component analysis with Varimax rotation and Kaizer Normalization was used to determine which factors have empirical significance. Factor retention was by the eigenvalue $\geq$ 2.0 criterion, suggesting that only factors that account for variances greater than two should be included in the factor extraction. This works best for this solution because individual variables have variance of 1.

The principal component analysis (Table24.1.), where linear combinations of observed variables are formed, was the method used to extract the factors. The first principal component is the combination that accounts for the largest amount of variance and the second principal component accounts for the next largest amount of variance and is uncorrelated with the first. From Table 24.2., component 1 has total variance of 5.218, which accounts for 15.813% of the total variance of the 33 factors. Component 2 has total variance of 2.239 accounting for 6.784% of the total variance of the 33 factors, and component 3 has a total variance of 2.088 accounting for 6.327% of the total variance of the 33 factors. These three components constitute 28.924% of the total variance of the 33 factors.

From the 33 factors identified from the literature as potential barriers to implementation of LC, and then confirmed through meetings with practitioners, factor analysis enabled 14 of these significant barriers to be placed under three components as follows;

Component 1: corruption, difficulty in understanding lean concepts, inconsistency in government policies, poor project definition, lack of equipment and delays in material delivery.

Component 2: incomplete designs, lack of standardization, extensive use of subcontractors, lack of buildable design and lack of agreed implementation methodology.

Component 3: the fragmented nature of the construction industry, lack of long term relationship with suppliers and lack of client and supplier involvement.

Table24. 1 Results from the factor analysis

No.	Item	Mean	Std. Dev	Component Matrix			Rotated Component		
				1	2	3	1	2	3
1	Lack of long term commitment to change and innovation	4.3	0.66						
2	Lack of top management support and commitment	4.26	0.72						
3	Corruption	4.25	0.83	0.54			0.55		
4	Lack of technical skills	4.24	0.76	0.51					
5	High level of illiteracy	4.23	2.93						
6	Inefficient use of quality standards eg. ISO 9000	4.21	0.79			0.56			0.64
7	Poor professional wages	4.19	0.69						
8	Poorly defined individual responsibilities	4.18	0.76						
9	Inadequate pre-planning	4.17	0.75						
10	High dependency of design specifications on insitu materials and components	4.16	0.75						
11	Incomplete designs	4.15	0.72					0.55	
12	Lack of long term relationship with suppliers	4.14	0.77			0.59			0.68

ISBN: 978-0-86970-713-5

13	Delays in decision making	4.13	0.79				
14	Lack of standardization	4.12	0.75			0.51	
15	Materials scarcity	4.11	0.73				
16	Difficulty in understanding lean concepts	4.11	0.76		0.57		
17	Inconsistency in government policies	4.11	0.78		0.66		
18	Lack of interests from clients	4.1	0.77				
19	Lack of training	4.09	0.85				
20	Lack of client and supplier involvement	4.09	0.79				0.57
21	Unsuitable organizational structure	4.08	0.67				
22	Extensive use of subcontractors	4.08	0.73			0.53	
23	Less involvement of contractors and specialists in design process	4.07	0.87				
24	Poor project definition	4.06	0.84	0.57	0.66		
25	Lack of supply chain integration	4.03	0.65				
26	Waste accepted as inevitable	4.03	0.74				
27	Lack of buildable designs	4.03	0.78			0.58	
28	Lack of equipment	4.02	0.77		0.62		
29	Lack of agreed implementation methodology	4.01	0.72			0.59	
30	Poor communication	3.98	0.76				
31	Delay in materials delivery	3.94	0.79	0.59	0.7		
32	Long implementation period	3.94	0.72				
33	Lack of awareness programms	3.92	0.86				

Note:
Valid N (listwise)= 400
Extraction method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalisation
KMO value= 0.68
Bartlett's Test of Sphericity Significance level= 0.000
Insignificant factor loadings (i.e. < 0.5) are blanked.

Table 24.2 Total Variance Explained

component	initial Eigen-values			Extraction sums of squared loadings			Rotation Sums of Squared Loadings		
	Total	**% variance**	**cumulative %**	**Total**	**% variance**	**cumulative %**	**Total**	**% variance**	**cumulative %**
1	5.218	15.813	15.813	5.218	15.813	15.813	3.774	11.437	11.437
2	2.239	6.784	22.597	2.239	6.784	22.597	3.365	10.197	7.29
3	2.088	6.327	28.924	2.088	6.327	28.924	2.406	7.29	28.924
4	1.842	5.583	34.506						
5	1.663	5.038	39.545						
6	1.485	4.5	44.045						
7	1.35	4.089	48.134						
8	1.314	3.981	52.115						
9	1.155	3.5	55.616						
10	1.137	3.445	59.061						
11	1.059	3.205	62.266						
12	0.966	2.928	65.194						
13	0.923	2.797	67.991						
14	0.885	2.681	70.672						
15	0.847	2.566	73.238						
16	0.807	2.444	75.682						
17	0.756	2.29	77.972						
18	0.739	2.241	80.213						
19	0.689	2.088	82.301						
20	0.644	1.95	84.251						
21	0.609	1.847	86.098						
22	0.567	1.718	87.816						
23	0.496	1.503	89.319						
24	0.481	1.456	90.775						
25	0.467	1.414	92.189						
26	0.441	1.337	93.526						
27	0.409	1.24	94.766						
28	0.378	1.147	95.913						
29	0.367	1.111	97.024						
30	0.315	0.956	97.98						

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31	0.265	0.803	98.783
32	0.218	0.661	99.444
33	0.184	0.556	100

Extraction method: Principal Component Analysis.

Based on the examination of inherent relationships among the factors under each component, the following interpretations were made to explain the underlining phenomenon linking the factors.

Component 1: Managerial issues

This component identified corruption, difficulty in understanding lean concepts, inconsistency in government policies, poor project definition, lack of equipment and delays in material delivery as major barriers to the implementation of lean construction. The top management of every organization has a major role to play in achieving a successful implementation of innovative strategies (Salem *et al*., 2005; Hudson, 2007, Bashir *et al*., 2010). The success of lean practice lies in the commitment of top management in developing and implementing an effective plan and adequately providing the required resources and support to manage changes arising from the implementation (Bashir *et al*., 2010). Without the support of top management, the professionals involved in construction may face numerous difficulties in adapting the lean construction concept (Kim and Park, 2006; Abdullah *et al*., 2009). The effect of top management issues on the implementation of lean construction has been well documented and the findings from this research agree well with literature (Common *et al*., 2000; Alarcon *et al*., 2002; Forbes and Ahmed, 2004; Alinaitwe, 2009). In order to deal with these managerial issues, the professionals interviewed suggested that management should establish proactive measures to prevent defective production, should ensure timely delivery of materials on site, should train employees on lean concepts and the opinion of employees should be considered in decision making. Other measures suggested include; Government agencies should embark on applicable policies that could provide critical support to make lean methods feasible, Management should monitor inflation risks and pricing levels that could provide the stability that organizations need in order to make lean methods feasible and Management should deal with uncertainties and fears that cause organizations to conceal information instead of sharing it.

Component 2: Technical issues

This component identified incomplete designs, lack of standardization, extensive use of subcontractors, lack of buildable design and lack of agreed implementation methodology as the major barriers to the implementation of lean construction. These barriers are considered technical because they have a direct impact on the success of application of lean construction principles and tools such as reliability, simplicity, flexibility and benchmarking (Bashir *et al*., 2010). Sub-contractors are mainly responsible for specialists' works. Contractors typically hire sub-contractors who do not have direct contracts with the client. Most sub-contractors work with inadequate resources and have low expertise, thereby often compromising quality (Forbes and Ahmed, 2004). Poor supervision of sub-contractors may result in lack of solution to critical problems involved in lean construction. Extensive use of sub-contractors who often lack technical expertise constitute a serious barrier to lean construction. Design over-sights and over adherence to standard design solutions can lead to buildability problems or constrain innovation that might offer more cost-effective solutions. Both of these would hold back the industry's desires to develop "leaner" approaches to construction (Construction Industry Research and Association, CIRIA, 2010). The designer is paid to produce a design expressed in the form of specifications and drawings. The contractor is expected to use these as a means of communication, and produce the completed facility. This communication often does not work as well as it should (Forbes and Ahmed, 2004). The problem might be due to the fact that the design lacks buildability and so cannot be interpreted. The effect of technical issues on the implementation of lean construction has been well documented and the findings from this research agree well with literature (Ballard and Howell, 1998; Koskela, 1999; Alinatwe, 2009 and Bashir *et al.*, 2010).

Component 3: Teamwork

This component identified the fragmented nature of the construction industry, lack of long term relationship with suppliers and lack of client and supplier involvement as barriers to the implementation of lean construction. Teamwork can be defined as "cooperative effort by the members of a group or team to achieve a common goal" (Bender and Septelka, 2002). It is common knowledge that various parties in the construction industry work as a team (Abdullah *et al.*, 2009). These team members share the common goal of completing the project to the satisfaction of the client, but because of conflicting and competing interest, a project may suffer from lack of teamwork (Bender and Septelka, 2002). These separate interests are due to the fragmented nature of the construction industry. If these parties are incapable of co-operating among themselves, the implementation of lean construction will definitely be negatively affected as it needs commitment and a strong co-operative network within all parties concerned. The success of lean construction is highly dependent on having a cohesive team working towards congruent goals and objectives. Contractors who purchase materials and services for 70-80% of their turnover (Frodell and Josephson, 2009) should realize the suppliers' part in the delivery and prioritize the value created by the suppliers in order to increase their competitiveness. The lack of long term relationships of construction companies with their suppliers has been attributed to the characteristics of the construction industry (Frodell and Josephson, 2009). The effect of teamwork on the implementation of lean construction has been well documented and the findings from this research agree well with literature (Mossman, 2009; Frodell and Josephson, 2009; Abdullah *et al.*, 2009; Bender and Septelka, 2002; and Bashir *et al.*, 2010).

Suggested measures to overcome barriers to sustainable implementation of LC

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The respondents were asked to evaluate the 17 measures identified from literature and confirmed through interviews with professionals. Table 24.3 presents mean scores, standard deviations and rankings of the 17 measures.

Table 24.3 Suggested measures to overcome barriers

MEASURES	MEAN SCORE	STANDARD DEVIATION	RANKING
Management should train employees on lean concepts	4.417	0.594	1
Communication should be improved among players in construction projects	4.365	0.774	2
Construction should ensure or maintain continuous improvement: thus, reduction of costs, increase quality and productivity	4.346	0.658	3
Construction managers should be committed to changes	4.234	0.661	4
Workers should be able to work in teams	4.218	0.788	5
Proactive measures to prevent defective production should be established by firms	4.141	0.680	6
Timely delivery of materials to construction sites	4.134	0.688	7
Firms should understand client needs and expectations and position themselves accordingly	4.131	0.630	8
Companies should be more client focused	4.106	0.878	9
Standardized construction elements should be promoted in the industry	4.080	0.816	10
Firms should be willing to change organizational cultures that do not promote lean construction	4.071	0.807	11
The opinion of employees should be considered in decision making	4.068	0.801	12
Government agencies should embark on applicable policies that could provide critical support to make lean methods feasible	4.067	0.924	13
Management should monitor inflation risks and pricing levels that could provide the stability that organizations need in order to make lean methods feasible	4.061	0.837	14
Management should deal with uncertainties and fears that cause organizations to conceal information instead of sharing it	4.060	0.893	15
Partnering should be promoted to maximize team building and development of trust	4.051	0.923	16
Team members should be empowered in decision-making to	3.923	0.986	17

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make partnerships meaningful

All the 17 measures have mean ratings of 2.50 or higher and therefore considered significant (Table 24.3). The results show that the five most significant measures to overcome barriers to sustainable implementation of LC in the Ghanaian construction industry are ‘management should train employees on lean concepts’, ‘communication should be improved among players in construction projects’, ‘construction should ensure or maintain continuous improvement: thus, reduction of costs, increase quality and productivity’, ‘construction managers should be committed to changes’, and ‘workers should be able to work in teams’. The findings of this study confirm that in the literature (Bashir et al., 2010). Bashir et al. (2010) stated that steps to overcome barriers to implementation of LC in the UK include taking full advantage of staff training on LC at all levels, engaging skilled site operatives, and promoting the LC concept to companies, professional bodies and major stakeholders. The UK construction industry also engaged in funding workshops and research that could generate more literature to guide LC implementation.

4. CONCLUSIONS AND RECOMMENDATIONS

From 33 factors identified by the Ghanaian building contractors and consultants as potential barriers to the implementation of lean construction, factor analysis enabled 14 of them to be placed under three components: (1) Managerial issues comprising corruption, difficulty in understanding lean concepts, inconsistency in government policies, poor project definition, lack of equipment and delays in material delivery; (2) Technical issues comprising incomplete designs, lack of standardization, extensive use of subcontractors, lack of buildable design and lack of agreed implementation methodology; and (3) Teamwork issues comprising the fragmented nature of the construction industry, lack of long term relationship with suppliers and lack of client and supplier involvement. To ensure the successful implementation of lean construction, management should train employees on lean concepts, ability to work in teams and establish proactive measures to prevent defective production, Construction managers should among others be committed to changes, understand client needs and expectations, and maintain continuous improvement (i.e. reduction of costs, increase quality and productivity. Government agencies on their part should embark on applicable policies that could provide critical support to make lean methods feasible. The identified barriers and possible measures to overcome them should provide an enabling environment for construction practitioners to successfully implement lean construction and improve construction quality and efficiency for the benefit of the client.

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10 Mar 07

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