Barriers to Implementing Lean Construction in the UK Construction Industry

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Abstract

Lean construction management efforts could prove to be highly rewarding for the UK construction industry. This was emphasised by the Egan Committee who stated that the concepts of lean thinking would lead the UK construction industry’s quest to improve quality and efficiency. Although various countries worldwide gained large benefits by adopting Lean Construction (LC) concepts, there still seems to be limited implementation of lean in the UK construction industry, over the last two decades, even after the publication of the Egan report. There appears to be a number of structural and cultural barriers that are militating against its successful implementation. By not realising the factors that affect the successful implementation of LC, organizations will not be able to know what improvement efforts need to be made, where these efforts should be focused, or which efforts could obtain best results (Leong & Tilley, 2008). For this reason, this study sought to identify and assess the possible barriers to the successful implementation of LC in the UK. Based on an extensive literature review, followed by a statistical analysis of data gained from a questionnaire survey which targeted practitioners in the UK construction industry, a number of barriers were identified as key barriers. Further analysis revealed that only three of these barriers were determined as significant. The results of this study could be used to help researchers, practitioners and companies in the UK construction industry to focus their attention and resources on the significant issues, crucial to support the successful implementation of LC.

Keywords: Lean Construction, UK construction industry, Structural and Cultural Barriers

Introduction

The Construction industry, according to researchers, is seen as a slowly progressing industry with numerous problems, and over the past 60 years the industry has commissioned several reports with the aim of reviewing its performance and suggesting means of improvement (Simon, 1944; Emmerson, 1962; Banwell, 1964; British Property Federation, 1983; Latham, 1994). The latest of these was the Egan report, ‘Rethinking Construction’, which was produced in 1998 to address concerns raised by clients engaging services of construction companies. At the heart of the Egan report was a desire to develop a change in the culture, style and management of the industry (Forbes & Ahmed, 2011). The report reviewed case studies from around the world where construction was attaining improvements, and amongst these were examples of lean thinking being applied successfully.
Since 1998, efforts to encourage the use of lean concepts in construction across most geographical areas of the UK has been growing, as exemplified in seminars staged by the Construction Industry Research and Information Association (CIRIA) and Construction Productivity Network (CPN) (Johansen et al., 2002). These efforts have been expanded to include the Construction Lean Improvement Programme (CLIP) that was created by the BRE in 2003 to promote case studies developed by Construction Excellence. The establishment of the Lean Construction Institute UK (LCI-UK) and some Lean Construction (LC) consultancy and promotional companies has also helped to enhance awareness of LC principles. Some organizations and universities now offer LC education, which has been helpful in moving lean thinking into the mainstream of construction education.

Despite these continuous efforts, a study by Common et al. (2000) has shown that the presence of a lean culture within large UK construction companies is significantly less than that professed. An even larger gap is evident from the level of development recognized in the LC literature review in other countries, in comparison to those in UK (Common et al., 2000). This is emphasised by Mossman (2009) and Bashir et al. (2010) who mentioned that although various countries gained large benefits by adopting LC concepts, there seems to be little implementation of lean in the UK construction industry, over the last two decades, even after the publication of the Egan report. There appears to be some structural and cultural barriers that prevent its successful implementation.

**Transforming Construction Using Lean Thinking: Lean Construction**

Lean thinking is a philosophy based on the concepts of lean production (Koskela, 1992; Koskela, 2000). According to Common et al. (2000) and Mossman (2009) lean principles date back at least as far as the early 1900’s, when Henry Ford introduced the principle of the assembly line that revolutionised car production. In the early 1950’s, lean production management principles were developed by Toyota led by engineer Ohno (Womack et al., 1990). Taiichi Ohno, the father of the Toyota Production System, focused his efforts into finding ways to convert waste ‘muda’ into value, and to alter attentions and thoughts from the narrow focus of craft production on worker productivity and mass production on machine to the entire production system (Womack & Jones, 1996; Howell, 1999). As stated by Womack et al. (1990) the term “lean” was invented by the research team working on the International Motor Vehicle Programme at Massachusetts Institute of Technology to reflect both the waste reduction nature of the Toyota production system and to contrast it with craft and mass forms of production.

Alternatively, the first consideration of the ideas of lean production for use within construction is attributed to Koskela (1992) (Garnett et al., 1998; Mossman, 2009). This seminal technical-report carefully considered the ideas expressed in the Machine that Changed the World within a construction context (Garnett et al., 1998). Koskela (1992) formulated the transformation-flow-value generation model of production, known as the TFV theory of production, which could lead to improved performance when applied to construction. He proposed the need to review construction production as a combination of conversion and flow processes to remove waste, when traditional thinking of construction was only focusing on conversion activities and ignoring flow and value considerations (Garnett et al., 1998; Senaratne & Wijesiri, 2008). Here, 8 types of waste are commonly agreed up on: Transportation, Inventory, Motion, Waiting, Over-Production, Over-Processing, Defects, Skills Misuse (Terry & Smith, 2011).
Since then, researchers started working closely with practitioners investigating the TFV theory and lean techniques (Alves & Tsao, 2007). Also, its publication initiated the formation of the International Group for Lean Construction (IGLC) in 1993, followed by other initiatives such as the Lean Construction Institute (LCI) in 1997; to promote lean principles in construction (Common et al., 2000).

Consequently, Womack and Jones (1996) described the thought process of lean and established the five principles of lean production. This theoretical foundation is called ‘Lean Thinking’ by them to differentiate from pure production activities (Terry & Smith, 2011). The five principles of lean are: Value, Value stream, Flow, Pull and Perfection (Womack & Jones, 1996). According to Garnett et al. (1998), the work done by Womack and Jones (1996) was seen as a strategic approach to achieving the lean production system described in the 1990 publication. “In a sense it was the general management philosophy alluded to by Koskela” (Garnett et al., 1998).

Founded in 1997 by Howell and Glenn Ballard, the LCI developed the Lean Project Delivery System (LPDS) and the Last Planner System (LPS) of Production Control, applying principles pioneered in manufacturing to construction (Ballard, 2000). The LPDS is divided into four interconnected phases: project definition, lean design, lean supply, and lean assembly. The Last Planner system is a tool which concentrates on the planning function of construction, using functions such as: ‘Look-Ahead Plan’ to plan what can be done when constraints are removed, and the ‘Percent Plan Complete’ (PPC) which monitors the Look-ahead Plan and requires reasons for delays, which are analysed in terms of root causes (Ansell et al., 2007).

Lean Construction (LC) is a different project management approach because it has a clear set of objectives for the delivery process, is aimed at maximizing performance for the customer at the project level, designs concurrently product and process, and applies production control throughout the life of the product from design to delivery (Howell, 1999). Abdel-Razek et al. (2007) believe that the core idea of LC is to reduce or eliminate waste, represented in non-value adding activities, and increase the efficiency of value adding activities. However, according to Koskela (1992) LC includes: practice of just in time (JIT), use of pull-driven scheduling, reduction of variability in labour productivity, improvement of flow reliability, elimination of waste, simplification of the operation, and implementation of benchmarking.

Evidence of the use of lean thinking has shown that there are many benefits to be made from applying lean principles to construction. These benefits claimed include: improved productivity, increased reliability, improved quality, more client satisfaction, increased predictability, shortened schedules, less waste, reduced cost, enhanced build-ability improvements to design, and improved safety (Lehman & Reiser, 2004; Mossman, 2009).

Lean construction efforts could prove to be highly rewarding for the UK construction industry. Various countries gained large benefits by adopting the lean concepts, but it does not seem to be generally applied amongst UK construction organizations (Bashir et al., 2010). There seems to be a number of barriers militating against successful lean implementation (Mossman, 2009). Therefore, the aim of this study is to identify the barriers that
may prevent the successful implementation of LC in UK; to enable the construction industry to focus its attention and resources on the real issues.

Barriers to the Successful Implementation of Lean Construction

The construction industry has rejected before many ideas from manufacturing because of the belief that construction is different; that is as projects in construction are one-off project based, more complex and take place under lots of uncertainties and constraints (Salem et al., 2006). There is a repeated claim that the construction industry is very different than manufacturing because every product is unique. Egan (1998) does not agree with that claim because he believes that the construction industry includes lots of repeated processes. The task force suggests that the construction industry has two options: “to ignore all this in the belief that construction is so unique that there are no lessons to be learned; or seek improvement through re-engineering construction, learning as much as possible from those who have done it elsewhere” (Egan, 1998). Likewise, Koskela (2000) believes that these types of barriers are just temporary; they may slow down the diffusion but will not impede it.

Several studies have been carried out in different countries worldwide to identify the barriers in implementing the LC approach. Some of these studies focused on investigating barriers that prevent the diffusion and implementation of LC (Johansen & Walter, 2007; Olatunji, 2008; Senaratne & Wijesiri, 2008; Abdullah et al., 2009; Mossman, 2009). Others focused on identifying barriers that exist during the execution of LC practices (Seymour, 1998; Garnett, 1999; Alarcon et al., 2002; Johansen & Porter, 2003; Jørgensen et al., 2004; Alarcón et al., 2005; Ansell et al., 2007). These barriers could affect the application process of LC and hinder the project performance, if not properly managed. By not understanding the factors that affect the successful implementation of LC, organizations will not be able to know what improvement efforts need to be made, where these efforts should be focused, or which efforts could obtain best results (Leong & Tilley, 2008). For this reason, an extensive literature review was conducted to understand the possible barriers to the successful implementation of LC. Based on a careful and comprehensive literature review relating to the barriers to implementing the LC approach, this study classifies these barriers into ten different categories, as shown below.

Fragmentation and subcontracting

Many similar factors in the construction industry of both developed and developing nations act as an obstacle to the adoption of LC concepts (Forbes et al., 2002). In both arenas, fragmentation and subcontracting in construction hinder the incentive for project participants to cooperate and learn together (Mossman, 2009). These participants have different circumstances and priorities, but with one shared objective of successfully completing the related project (Abdullah et al., 2009). Therefore, it is essential to establish effective communication between all parties by embarking on the partnering and integrated team-working route (Thomas & Thomas, 2005). That is because, in the process of implementing the LC concepts, poor communication will have a negative impact on the effectiveness of the project delivery and coordination system (Abdullah et al., 2009).
Additionally, in construction projects, contractors traditionally hire subcontractors. These subcontractors generally do not have contracts with the client; and may sometimes have to work with insufficient budgets, even if the client pays a fair price to the main contractor (Forbes et al., 2002). As a result, this often leads to compromised quality of work. Although, some clients have tried to overcome these barriers by providing framework opportunities and partnering contracts, these usually only involve the main participants (Mossman, 2009).

**Procurement and contracts**

Traditional Procurement methods and contracts undermine the application of lean principles, because they seem to create adversarial relationships between parties involved (Mossman, 2009) and can add waste to the process (Cullen et al., 2005). According to Cullen et al (2005), contract forms that allow one party to impose power over another create adversarial relations. These adversarial relations create transaction costs which are considered waste, and are thus opposing to the lean philosophy. Mossman (2009) suggests that recent contracts such as PPC2000, Be, NEC3, and the new JCT-Constructing Excellence Contract are moving in the lean direction.

In addition, Johansen and Walter (2007) stated that any procurement form that tends to delegate design work to external designers, without any follow-up or incorporation, separates the design from the construction process; and therefore misses the lean aim of collaboration and integration. Therefore, selecting a collaborative procurement system with a significant emphasis on concurrent design and construction, would be recommended for the successful implementation of LC (Common et al., 2000).

**Culture and human attitudinal issues**

Applying Lean thinking principles into the construction industry requires a fresh approach in thinking about the complete process; in order to remove ‘waste’, create ‘continuous flow’, and radically enhance ‘value’ to the customer. On contrast, the culture of the UK construction industry is known to be opportunistic, prone to conflict and resistant to change (Rooke et al., 2003; Rooke et al., 2004). Therefore, changing traditions and behaviour seems to be a necessary prerequisite for implementing LC in the UK (Seymour, 1998; Garnett, 1999; Common et al., 2000). Based on researches and case studies conducted by Common et al. (2000), Alarcon et al. (2002), Johansen and Porter (2003), Johansen et al. (2004), Jorgensen et al. (2004), Alarcon et al. (2005), Salem et al. (2006), Olatunji (2008), Abdullah et al (2009), and Mossman (2009), these factors include: lack of commitment, lack of ability to work in group, lack of self-criticism, weak communication and transparency among teams of the production process, cultural issues in getting the subcontractors and workers to adopt the methodology in a comprehensive way, fear of taking risk, wrong attitude to change, not viewing housekeeping as a continuous effort, lack of team spirit among professionals, over-enthusiastic champions, dependency, lack of incentives and motivation, lack of trust, and fear of blame and contractual disputes.
Adherence to traditional management concepts due to time and commercial pressure

One of the main barriers to the successful implementation of LC is the tendency of construction firms to apply traditional management concepts as opposed to productivity and quality initiatives (Abdullah et al., 2009). According to Common et al. (2000), it seems that commercial pressure to do the deal takes place over production issues. For that reason, Mossman (2009) advises companies not to wait for a crisis to make efforts to change; because it would be then too late to learn new skills and ways of thinking. Consequently, Abdullah et al. (2009) stresses that if construction firms keep stuck to their current management concepts, as they are satisfied with achieving their intended objectives, they will become reluctant to any changes even though these changes may help to improve their performance and increase their quality and productivity rates.

Financial issues

The successful implementation of LC requires adequate funding to provide relevant tools and equipment, sufficient professional wages, incentives and reward systems; investment in training and development programmes, and perhaps employing a lean specialist to provide guidance to both employers and employees during the initial implementation (Bashir et al., 2010). Studies conducted by Dulaimi and Tanamas (2001), Olatunji (2008), and Mossman (2009) have revealed some common financial barriers that need to be carefully addressed. These include: inflation, inadequate funding of projects, unstable markets for construction, lack of basic sociable amenities required for facilitating the lean implementation, lack of incentives and motivation, low professional remuneration, unwillingness of some companies to invest extra funds to provide training for their workers more than the essential legislation requirement.

Lack of top management commitment and support

The successful implementation of LC or any new innovative strategy needs to be supported by top management. Top managers have to provide sufficient time and resources to develop an effective plan, and manage changes arising from the implementation process (Bashir et al., 2010). Although studies carried out by Abdullah et al. (2009), and Alinaitwe (2009) have identified lack of top management leadership and commitment as a main barrier to the implementation of LC, Mossman (2009) believes that the problem exists with middle management not top management. For middle managers the benefits are not very clear and their training and experience is not sufficient to provide them with the ability to manage change in thinking, responsibility and roles. Alternatively, benefits for top management from implementing LC concepts are very clear: increased productivity, reduced time and accidents (Mossman, 2009). However, several studies reported various management related issues such as: poor planning, lack of delegation to enhance work flow, poor understanding of customer needs, lack of a participative management style for the workforce, logistics’ problems, absence of look-ahead planning and poor coordination (Shammas-Toma et al., 1998; Johansen & Porter, 2003; Olatunji, 2008; Alinaitwe, 2009).

Design/ construction dichotomy

Design and planning are identified as major attributes of the process of LC. Any ignorance to the importance of these could lead to disastrous loss of time, cost and the overall process (Common et al., 2000). Due to traditional
contractual procedures, design and implementation of design are treated as separate products (Rooke et al., 2007). This causes a conflict border between the two phases and creates lots of waste such as: incomplete and inaccurate designs, rework in design and construction, lack of buildable designs, final products with significant variation from values specified in the design, and disruption to contractors due to design changes made by designers (Shammas-Toma et al., 1998; Rooke et al., 2007). According to Seymour and Rooke (2000) designers usually ignore the production conditions in which their designs will be implemented. There is an argument on how to solve uncertainties of work on site and on how quality could be achieved. Some view the attainment of quality as a factor of relationships and good coordination, while others see it as a matter of strict adherence to specifications and codes (Shammas-Toma et al., 1998).

A suggested solution to this design/construction dichotomy could be the use of the British Standard (BS) 5606:1990 (Seymour & Rooke, 2000; Rooke et al., 2007). The BS 5606 provides a formula for site personnel to calculate the consequences for the achievement of specified tolerances. Also, designers can make adjustments in their specifications to code recommendations if they anticipate circumstances on site that will make strict adherence to the code difficult or impossible. However, this still requires good collaboration and coordination between the two parties, and is subject to the multiple vagaries of inter-personal relations on site (Seymour & Rooke, 2000; Rooke et al., 2007). Another suggestion by Shammas-Toma et al. (1998) is giving the contractor the responsibility for the reinforcement detailing. According to them, designers themselves acknowledged their limitation in producing buildable reinforced concrete designs; where poor detailing can account for about 20% of reinforcement which in turn is about 25% of the contract. This suggestion may lead to improved constructability, and gives the contractor some control during the design phase; this involvement could also encourage the take-up of Design & Build contracts (Shammas-Toma et al., 1998).

However, one promising aspect is the tendency in the construction industry to adopt integrated design to enhance performance and add value to the final products. There are two opposing views regarding the way to adopt traditional design practices to the new trend of work (Forgues & Koskela, 2009). Promoters of sustainable construction hypothesize that it is a matter of developing from a sequential to an iterative design process; but the British government argues that a change to the context in which the design is realized is essential and requires a change in how projects are procured (Forgues & Koskela, 2009). Findings by Forgues and Koskela (2009) demonstrated that: problems with integrated design team efficiency are related to context and not process, traditional procurement processes strengthen socio-cognitive barriers that hinder team efficiency, and new collaborative procurement approaches help to mitigate socio-cognitive barriers and improve integrated design team performance.

**Lack of adequate lean awareness/understanding**

Lean thinking principles have been adopted from manufacturing sectors to the construction industry (Eriksson, 2009). Therefore, many LC principles and techniques are referred to those contained within lean manufacturing. There is a debate on the extent to which methods of lean production are applicable to LC (Green, 1999a; Green, 1999b; Howell & Ballard, 1999; Green, 2000). Some lean production measures may not be equally applicable in construction and may need to be amended (Eriksson, 2009). Abdullah et al. (2009) suggests that it is essential to have a full comprehension about lean manufacturing concepts in advance, in order to be able to clearly understand the concept of LC.
Additionally, many studies have reported the lack of exposure on the need to adopt LC, and difficulties in understanding its concepts to be significant barriers to the successful implementation of LC (Johansen et al., 2002; Johansen & Porter, 2003a; Ansell et al., 2007; Abdullah et al., 2009). This could be due to the lack of a shared and agreed definition or understanding of what is meant by lean (Green, 1999a; Jørgensen & Emmitt, 2008; Mossman, 2009). Eriksson (2009) does not agree with that claim because he believes that the definition and understanding of LC, as for other innovative management practices like partnering, would be best developed by investigating its core elements.

Furthermore, LC has introduced to the construction industry the usage of new tools which have a distinct difference when compared to those used in traditional practices. According to Abdullah et al. (2009) these differences have to be clearly understood in order for these tools to be optimally utilised. However, several researchers believe that lean is more than tools or techniques; instead it requires a transformation in thinking, collaboration, flexibility, commitment, discipline, and a broad system-wide focus (Rooke et al., 2007; Mossman, 2009; Terry & Smith, 2011). Lean has to be implemented across the business and value chain to deliver the promised results; any isolated efforts may even cause waste (HA, 2009).

A study by Common et al. (2000) revealed that there is a considerable lack of understanding to the fundamental concepts and application of lean within UK construction companies. For instance, a majority of the respondents considered that the lean concept is not suitable for the construction industry because of the demands from clients for quicker and cheaper projects. This is inconsistent with the principles of lean of eliminating waste to reduce time and cost, and add value to the client. Also, many companies that professed to be applying LC principles seemed to combine traditional techniques with those that are considered lean. A typical combination was the use of traditional contracting, critical path planning and supply chain management (SCM). Although SCM and partnering are important attributes to the successful implementation of LC, the use of traditional contracting and critical path planning (CPP) hinders their effects. That is because both traditional contracting and critical path planning have been identified as contributors of waste in construction (Common et al., 2000; Johansen & Walter, 2007). Furthermore, only a few companies recognized the importance of design and planning to the process of LC.

Educational issues

Although there have been several efforts to provide awareness and guidance to LC by researchers, academics, practitioners and professional bodies in the UK and some other countries, it seems that educational barriers could pose a great threat to the sustainable implementation of LC (Bashir et al., 2010). Some of these barriers include: lack of technical skills, ignorance to human resource management and development, inadequate training, poor understanding and awareness, poor team-work skills, illiteracy and computer illiteracy (Green, 1999a; Alarcon et al., 2002; Johansen & Porter, 2003; Jørgensen et al., 2004; Olutunji, 2008; Abdullah et al., 2009; Mossman, 2009).
Lack of customer-focused and process-based performance measurement systems

There is an industry tendency to measure performance in terms of time, cost and meeting code; but very limited consideration has been subjected to client satisfaction (Forbes et al., 2002). These traditional performance preferences measured in projects, specifically costs and schedule, are not appropriate for continuous improvement because they are not effective in identifying the root-causes of quality and productivity losses (Alarcon & Serpell, 1996).

Traditional Performance measurement systems (PMSs) are based on financial measures (Lantelme & Formoso, 2000; Suwignjo et al., 2000). The latter are result-oriented performance indicators, and have been strongly criticised by many researchers (Alarcón et al., 2001; Mitropoulos & Howell, 2001; Takim & Akintoye, 2002; Costa et al., 2004; Moon et al., 2007; Nudurupati et al., 2007; Leong & Tilley, 2008). That is because these parameters are backward focused (Lantelme & Formoso, 2000). They are not measured until project is complete; and thus the information obtained arrives too late to take any corrective actions (Alarcón & Serpell, 1996; Moon et al., 2007). As a result, these outcome based indicators cannot be used to identify barriers or problems that exist during the execution of processes. According to Alarcón et al. (2001) traditional control systems focus their attention in conversion activities and ignore flow activities; therefore nearly all non-value-adding activities become invisible.

Instead, Costa et al (2004) recommends the use of leading measures aiming to give early warnings, identify barriers and potential problems, and emphasize the need for future investigation. This recommendation is supported by Neely et al. (1996) who asserted the need to adopt formal process based approaches. It is important to use measures for tracking improvement by detecting the problems and their root causes, not just reporting (Alarcón et al., 2001; Terry & Smith, 2011).

Research Method

This research paper focusses on the challenges to implementing lean construction - structural and cultural barriers and is part of a larger programme of study (Sarhan, 2011). The study employed a mixed methods approach involving a questionnaire survey and semi-structured interviews to collect quantitative and qualitative data. This paper is based on findings from the questionnaire survey which included 36 questions and aimed to explore various aspects of the conceptual framework developed by Sarhan and Fox (2012). An invitation to complete the questionnaire was sent to 198 professional practitioners in the UK construction industry as well as a small sample of academics (10 for a pilot study and 188 for the main study). Participants were selected randomly from a number of professional groups that represent many of the professional organisations involved in the UK construction industry. The survey was hosted online for two weeks; and a total of 140 responses were received. This represents a response rate of 74.5%. The results obtained indicated that the study was able to capture a well distributed mixture of professionals and organisations (see Tables 1 and 2). The largest proportion of the participants was for civil engineers (34%). In addition, more than half of the respondents (63%) were from practitioners holding managerial positions and with more than 10 years of experience in the industry.
Table 1: Distribution of the sample in percentage (Clustering of organisations)

<table>
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<tbody>
<tr>
<td>1-100</td>
<td>&lt;500 employees</td>
<td>Private</td>
</tr>
<tr>
<td>100-1000</td>
<td>&gt;500 employees</td>
<td>Public</td>
</tr>
<tr>
<td>1000+</td>
<td></td>
<td>Both</td>
</tr>
<tr>
<td>40%</td>
<td>46%</td>
<td>14%</td>
</tr>
<tr>
<td>31%</td>
<td>54%</td>
<td>26%</td>
</tr>
<tr>
<td>29%</td>
<td></td>
<td>60%</td>
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</tbody>
</table>

Table 2: Distribution of the sample in percentage (Clustering of individuals)

<table>
<thead>
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<tbody>
<tr>
<td>0-10</td>
<td>Graduate /Junior</td>
<td>Practical qualification</td>
</tr>
<tr>
<td>10-20</td>
<td>Middle management</td>
<td>Bachelor’s degree</td>
</tr>
<tr>
<td>20+</td>
<td>Senior management</td>
<td>Master’s Degree &amp; above</td>
</tr>
<tr>
<td>37%</td>
<td>14%</td>
<td>25%</td>
</tr>
<tr>
<td>26%</td>
<td>26%</td>
<td>36%</td>
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<tr>
<td>37%</td>
<td></td>
<td>39%</td>
</tr>
</tbody>
</table>

For this research paper, an extensive literature review was conducted to understand the possible barriers to the successful implementation of LC in the UK. Based on a thorough analysis of these barriers, they were merged and classified by the authors into 10 different categories as key barriers. A question was then formulated and included in the electronic survey to:

i. See if the real world agrees with the study’s identification of the key barriers to the successful implementation of LC;

ii. Identify the most significant barriers according to its influence on the implementation of LC, based on the mean values obtained.

iii. Prioritise/Rank the barriers identified with the aim of evaluating its effect on the successful implementation of LC.

The respondents were asked to rate a range of barriers on a five-point Likert scale to indicate the level of influence, ranging from “5” equal to strongly agree to “1” equal to strongly disagree. Hence the measurement of reliability is essential to the validity of the results (Lam et al., 2007); the data received for this question were entered into SPSS 19.0 software to evaluate its reliability using Cronbach’s Alpha coefficients. The data received from this question was entered into SPSS 19.0 software to evaluate its reliability using Cronbach’s Alpha coefficients. The coefficient obtained a value of 0.747 which indicates the “reliability” of the results as it is greater than the acceptable threshold (0.7) (Lam et al., 2007; Ab Rahman et al., 2011). The mean values of the key barriers were then determined to indicate the level of influence of each of these barriers on the successful implementation of LC from the respondents’ perspective. If the mean value scored “4” or above to a particular barrier, then it would be classified as a significant barrier as such a score is a common threshold for significance used in previous research (Chan, 2003; Lam et al., 2007).
Research Results and Analysis

All the key barriers identified by the study were recorded by responses in terms of influence with more than 50 per cent frequency (Table 3). This suggests that the majority of the respondents agreed with the study’s identification of the key barriers to the successful implementation of LC.

Table 3: Influence of the barriers identified on the successful implementation of LC

<table>
<thead>
<tr>
<th>ID</th>
<th>List of the key barriers identified</th>
<th>Answer Scale* (5= Strongly Agree and 1= Strongly Disagree)</th>
<th>Frequency Score Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>B1</td>
<td>Fragmentation &amp; subcontracting</td>
<td>26</td>
<td>49</td>
</tr>
<tr>
<td>B2</td>
<td>Procurement &amp; contracts</td>
<td>22</td>
<td>47</td>
</tr>
<tr>
<td>B3</td>
<td>Lack of adequate Lean awareness &amp; understanding</td>
<td>50</td>
<td>48</td>
</tr>
<tr>
<td>B4</td>
<td>Culture &amp; human attitudinal issues</td>
<td>35</td>
<td>54</td>
</tr>
<tr>
<td>B5</td>
<td>Time &amp; commercial pressure</td>
<td>29</td>
<td>51</td>
</tr>
<tr>
<td>B6</td>
<td>Financial issues</td>
<td>17</td>
<td>43</td>
</tr>
<tr>
<td>B7</td>
<td>Lack of top management commitment</td>
<td>42</td>
<td>44</td>
</tr>
<tr>
<td>B8</td>
<td>Design/Construction dichotomy</td>
<td>20</td>
<td>34</td>
</tr>
<tr>
<td>B9</td>
<td>Educational issues</td>
<td>18</td>
<td>52</td>
</tr>
<tr>
<td>B10</td>
<td>Lack of the use of process-based PMSs</td>
<td>16</td>
<td>49</td>
</tr>
</tbody>
</table>

*Scale 3 is considered neutral and is categorised within the non-influencing group.

As can be seen from Table 4 below, the mean values of three barriers, namely: B3, B7 & B4 exceeded the cutoff point (a mean score of 4.0 and above) and thus were considered as the significant barriers to the successful implementation of LC. It is also noticeable that these three barriers obtained the lowest standard deviations, which suggests that the participants were quite certain about these barriers more than all others.
Based on the participants’ perspectives on the influence of the barriers identified on the successful implementation of LC, and by referring to the mean analysis findings (shown in Table 5.6), these barriers were ranked and illustrated as shown in Figure 1.

Table 4: The significant barriers to the successful implementation of LC in the UK

<table>
<thead>
<tr>
<th>ID</th>
<th>Key barriers</th>
<th>Mean</th>
<th>St. dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>Fragmentation and subcontracting</td>
<td>3.76</td>
<td>0.99</td>
</tr>
<tr>
<td>B2</td>
<td>Procurement and contracts</td>
<td>3.69</td>
<td>0.95</td>
</tr>
<tr>
<td>B3</td>
<td>Lack of adequate lean awareness and understanding</td>
<td>4.30</td>
<td>0.76</td>
</tr>
<tr>
<td>B4</td>
<td>Culture &amp; human attitudinal issues</td>
<td>4.04</td>
<td>0.86</td>
</tr>
<tr>
<td>B5</td>
<td>Time and commercial pressure</td>
<td>3.89</td>
<td>0.97</td>
</tr>
<tr>
<td>B6</td>
<td>Financial issues</td>
<td>3.47</td>
<td>1.01</td>
</tr>
<tr>
<td>B7</td>
<td>Lack of top management commitment</td>
<td>4.06</td>
<td>0.94</td>
</tr>
<tr>
<td>B8</td>
<td>Design/Construction dichotomy</td>
<td>3.34</td>
<td>1.18</td>
</tr>
<tr>
<td>B9</td>
<td>Educational issues</td>
<td>3.58</td>
<td>1.03</td>
</tr>
<tr>
<td>B10</td>
<td>Lack of the use of process based PMSs</td>
<td>3.54</td>
<td>0.98</td>
</tr>
</tbody>
</table>

Note: The shaded areas represent the significant barriers identified.
As revealed in Figure 1, it appears clearly that financial issues (B6) were not considered by the respondents as a main threat to the implementation of LC in the UK, seeing that the respondents ranked it very low (9th out of 10). It is also obvious that the three significant barriers identified are more likely to be classified as cultural barriers rather than structural. This emphasises the importance of establishing a lean culture among the UK construction industry to support lean transformations in design and construction organisations and projects.

Further analysis of the results revealed that there was a strong level of agreement amongst all sub-classifications of the study that the lack of adequate lean understanding (B3) is the most significant barrier to the implementation of LC. All of these results should be seen positively; as they indicate that the professionals in the UK construction industry have the capacity for self-criticism, which was identified by Johansen & Walter (2007) as one of the fundamental behavioural aspects needed if a lean culture is to be established in an organisation.

This study provided a snapshot of opinions obtained from 140 professional practitioners in the UK construction industry, as well as, a small sample of academics with an interest in LC. Due to the diversity and well distributed mixture of the sample (See Tables 1 and 2) the authors consider the sample to be representative of the UK construction industry; and also believe that the findings obtained could be generalised throughout the whole UK construction industry.

**Conclusion and Recommendations**

Lean construction (LC) efforts could prove to be highly rewarding for the UK construction industry. Although various countries worldwide gained large benefits by adopting the lean concepts, it does not seem to be generally applied in the UK construction industry. There appears to be a number of structural and cultural barriers that are hindering the progress of UK construction organisations towards achieving the lean approach.
This study assessed a number of barriers to the successful implementation of LC and three were identified as significant, according to the participants’ opinion, namely: [1] Lack of adequate lean awareness and understanding; [2] Lack of top management commitment; and [3] Cultural & human attitudinal issues. The findings of this study could be used to help researchers, practitioners and companies in the UK construction industry to focus their attention and resources on the significant issues necessary to support the implementation of LC concepts. A qualitative research approach is recommended to investigate the nature of the significant barriers identified, to allow further studies to propose strategies for overcoming barriers to implementing LC.

References


