Watfa, Mohamed and Sawalha, Murad (2021) Critical Success Factors for Lean Construction: An Empirical Study in the UAE. *Lean Construction Journal* 2021 pp 01-17 (submitted 31Jan2021; Accepted 31Mar2021) www.leanconstructionjournal.org

Critical Success Factors for Lean Construction: An Empirical Study in the UAE

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Abstract

Research Questions: Q1) what are the Critical Factors that are essential for the successful implementation of Lean Construction? Q2) how can we put these factors into action to implement the Lean Construction?

Purpose: The purpose of this paper is to find out the most important factors that are considered critical to successfully implement the Lean in Construction projects, and to develop a conceptual framework that represents the foundation for adopting Lean Construction.

Research Method: The authors conducted a comprehensive literature review and a survey is used to collect data from local construction companies in the United Arab Emirates (UAE). Collected data are then analyzed and used to answer the research questions.

Findings: This study identified 13 Critical Success Factors (CSFs) for Lean implementation in construction projects. The factors were then categorized into four main constructs that represent the pillars of the conceptual framework: Managerial, Organizational, Structural, and External Factors. A preliminary "Staircase Road Map" is proposed to guide construction companies in diffusing the Lean techniques.

Limitations: The consistency of the research results and findings is dependent on the accuracy and reliability of the collected data from UAE construction companies. Also, the study focused on local construction companies with other stakeholders' perspectives being excluded.

Implications: The study proposed a conceptual framework that represents the foundation or the building block for applying Lean techniques in construction projects.

Value for Practitioners: This study will enable construction companies to understand the key requirements and factors essential for the success of Lean Construction program, allowing them to focus on fulfilling these requirements before and during the implementation, thus reducing the chances of program failure.

Keywords: Lean Construction, Critical Success Factors (CSFs), Successful Implementation.
Paper type: Full paper.

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Introduction

To survive in today's competitive business, it has become essential for construction companies to improve their performance. Nowadays, with the ever-increasing customers' demand, projects rarely finish on-time, within budget, creating significant challenges for construction organizations. Several approaches have emerged recently to overcome these issues, Lean Construction was one of these concepts that captured the interest of both researchers and practitioners lately. Lean Construction, as defined by the Lean Construction Institute (LCI), is a production management-based project delivery system emphasizing the reliable and speedy delivery of value. The goal is to build the project while maximizing value, minimizing waste, and pursuing perfection (LCI, 2012). Lean Construction adopts the Lean Thinking philosophy in construction project environments.

Although the concept of Lean Construction is still new to many construction firms, previous studies showed a cost reduction using lean techniques (e.g. Andersen et al., 2012; Ballard and Reiser, 2004). According to Ballard and Howell (2003), countries such as UK, Australia, and USA have gained significant benefits by adopting Lean concepts in construction field. However, despite the benefits Lean Construction can bring to organizations, there have been several failures in the implementation, the implementation of this initiative is filled with numerous challenges (Mossman, 2009).

Prior to adopting Lean, construction companies need to understand the key issues and requirements surrounding this initiative by realizing the factors that influence it's success and failure, this will enable them to focus their efforts on these issues before the implementation and fill the gaps, thus, reducing the chances of failure.

Several studies addressed Lean Construction from different perspectives, however, it appears that the majority of these studies focused primarily on implementing Lean tools and practices in construction projects, ignoring the fundamental elements behind the success of these tools such as Human and organizational issues (Pavez & Alarcón, 2006). Moreover, previous studies on Lean Construction CSFs (e.g. Pavez & Alarcón, 2006; Ballard et al., 2007) have focused on internal elements within the organization boundaries, and neglected the external factors that influence the success. Therefore, this study attempts to narrow this gap by studying a broader perspective of the Lean Construction CSFs encompassing both internal and external levels.

This study aims to build on previous research into lean and the associated factors reported in various contexts to empirically address the question of CSFs. Based on an extensive literature review in the related fields, a list of factors were gathered and organized, after which a survey questionnaire was designed and distributed to local construction companies in the UAE. Collected data has been analyzed statistically and results are presented and discussed. Finally, a Conceptual Framework and a staircase roadmap were proposed to achieve the purpose of the study.

Critical Success Factors

Rockart (1979) defined CSFs as "*The limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organization*". Successful implementation of lean principles in the construction industry depends upon certain key enabling factors. These need to be identified, documented and

clearly communicated to a wider set of stakeholders to improve the chances of success. The review of the literature in the fields of Lean Management and Lean Construction reveals a list of reported factors that were most commonly cited as "critical" for the successful implementation. It is those factors which we will build on to empirically address the question of CSFs.

Management Commitment & Involvement

Management commitment and involvement in the Lean implementation is a very important factor for the success of this initiative (e.g. Ballard et al., 2007, Kim and Park, 2006; Porwal et al., 2010; Fernandez et al., 2013). Researchers argue that it is top management who should drive the change mind-set into the organization by setting up goals and objectives and ensure working towards achieving them (Alarcón et al., 2006; Achanga et al., 2006). Lack of management commitment to the program has been reported as one of the main barrier towards the implementation in many studies (e.g. Bashir et al., 2010; Mossman, 2009; Salem et al., 2006). Mossman (2009) believes that the problem exists with middle management not top management. Moreover, the involvement of the top and middle management in the program is crucial since it's necessary for motivating the staff, ensuring the objectives are being achieved and allocating resources (Tsang and Antony, 2001). Hence, two sub-factors were considered under this factor, namely: management commitment to Lean program, and management involvement in the program.

Management Leadership

Strong leadership from the top and site management is necessary to ensure the success to the program (Ballard et al., 2007). It is essential for management to create a quality culture by empowering and motivating other employees (Achanga et al., 2006), and by creating the right working environment characterized by openness in order to eliminate the fear factor. This can only be achieved by strong leadership from management. Porwal et al. (2010) claimed that lack of management leadership is one of the main barriers in the implementation.

Employees' Participation and Motivation

In Lean philosophy, employees are considered to be the core of the company and a key element in the Lean system. They need to be encouraged and involved in the Lean program to ensure success (Shah and ward, 2007). Lean requires all employees to participate in the decision making by providing suggestions to improve the processes. It is also vital to motivate and empower the participants by creating the right environment in which employees are recognized and encouraged, resulting in changing their attitude and overcoming their resistance to change. Several authors stated that human attitude issues and resistance to change was one of the main barriers that prevented the diffusion of Lean Construction (e.g. Alarcón et al., 2006; Mossman, 2009; Johansen et al., 2007; Salem et al., 2006; Ballard et al., 2007, Olatunji, 2008). Accordingly, two sub-factors were considered, namely: Motivation & Empowerment of employees, and employees' involvement and participation in lean program.

Training and Knowledge

The implementation of Lean requires a good degree of technical knowledge about the tools and techniques required for the proper implementation, hence, providing training is essential for Lean Construction implementation (Kim & Park, 2006; Alarcón et al., 2006; Ballard et al., 2007). Training should cover the basic concepts of Lean and the specific tools the company is interested in. The study by Kim and Park (2006) found that providing training courses in Lean has brought a lot of benefits in the deployment, however, they found that while the main contractor workers and staff have a good knowledge about the lean tools, their subcontractors lack the awareness and understanding of basic lean concepts, this impacted the deployment at some stages. Hence, two sub-factors were considered, namely: providing Lean Training courses, and training should cover sub-contractors and main suppliers.

Skills and Expertise

The review of the literature reveals that in order to successfully implement the Lean program, the skill and expertise of the workers and employees is considered to be crucial since some lean tools and techniques requires a good level of skills, this was reported in several studies (e.g. Saurin et al., 2011; Achanga et al., 2006; Nordin et al., 2012) This can be achieved by training the current employees or by hiring employees who have the knowledge and skills in Lean Construction tools. Since training has been captured previously, one sub-factor will be considered, namely, hiring employees who have knowledge and experience in lean system.

Communication and Collaboration

An effective communication between employees and departments is essential for the success of any improvement initiative (Nordin et al., 2012). Efficient and frequent communication provides the employees with guidelines and maintain the momentum in lean implementation (Puvanasvaran et al, 2009). Ballard et al. (2007) reported Communication as one the CSFs for Lean Construction. Furthermore, cross-functional collaboration between departments have been identified as one of the key success factors for implementing Lean in Construction as well (Alarcón et al., 2006). Thus, two sub-factors were considered under this factor, namely: effective communication system, and cross-functional team work (collaboration).

Financial Capability

The implementation of Lean requires financial investment in resources and training (Achanga et al., 2006). Organizations need to assign significant budget in order to successfully implement a new management initiative by investment in training and hiring experts or consultants. Financial capability has been reported as one of the barriers towards implementing Lean in construction in several studies (e.g. Bashir et al., 2010; Sarhan & Fox, 2013; Mossman 2009; Olatunji, 2008).

Process Documentation and Standardization

Process management is essential for identifying non-value-adding activities and increasing quality, ineffective processes lead to more waste and lower productivity per employee (Lewis et al., 2006). Hence, the organization should have a well-documented

processes in order to implement the Lean practices (Saurin et al., 2011). On the other hand, in order to avoid misunderstanding regarding work processes and procedures, the company should standardize the activities (Liker, 2004). In their study, Ballard et al. (2007) reported that Standardization was one of the CSFs for Lean Construction. Accordingly, two sub-factors were considered under this factor, namely: Process Documentation, and activities Standardization.

Strategy & Planning

It is important to put in place a Lean implementation strategy prior to the implementation (Achanga et al., 2006), first by determining the type of lean tools and techniques the organization should peruse according to their needs the scope of the lean program (Bhasin and Burcher, 2006), the strategy should also include human and financial resource allocation, hiring and training plans, and the long term objectives. On the other hand, planning is necessary to ensure successful implementation, planning entails establishing a structured methodology for the implementation, as well as developing a detailed cost and schedule estimation (Achanga et al., 2006). Consequently, two sub-factors were considered, namely: Lean Implementation Strategy, and Planning the implementation.

Benchmarking

Benchmarking is a method of keeping a close eye on the competitors. Benchmarking performance against other top-class companies will allow the organization to understand any threats from competitors, which could drive improvements (Gurumurthy and Kodali, 2009). In their study, Ballard et al. (2007) found that Benchmarking was one the CSFs for Lean Construction since it enabled the companies to identify the opportunities and benefits of adopting Lean Construction, as well as the most suitable tools and practices.

Organizational Culture

The organizational culture elements have been extensively investigated by the researchers as a key factor for implementing Lean and Lean Construction (e.g. Ballard et al., 2007; Nordin et al., 2012; Kim and Park, 2006; Gao et al., 2014; Liker, 2004) It can be seen that organization culture which doesn't accept failure or change will fail in implementing any new improvement initiative. It's important to realize that the transformation to Lean requires massive changes by creating the right culture, and the conditions which can become the foundation for implementing change, moreover, the culture in Lean includes encouraging people to participate in the process; if the organization can engage people to participate, and convince them to accept the changes, it will result in creating a lean culture with more people motivated towards the change (Liker, 2004). In their study, Fernandez et al. (2013) reported that Cultural issues and resistance to change were found to be the main barriers in Last Planner implementation.

Contractor Involvement

In Lean philosophy, suppliers have great importance due to their influence on processes. Lean Construction encourages the involvement of the contractors early in the design stage, consequently a new concept emerged recently, Early Contractor Involvement (ECI) was initially proposed by Song et al. (2009), they defined ECI as "a relationship

between a contractor and an owner (client) or a designer that engages the contractor from the early design stage and allows the contractor to contribute its construction knowledge and experience to design". Several authors have discussed the advantages of the ECI and the vital role it plays, reporting that the major benefits of applying the ECI lays in the information sharing between the designers and contractors early in the design stage of the project, which, in turn, will drive several benefits to the project (Sødal et al., 2014) Rahman and Alhassan (2012) summarized the benefits of adopting ECI into three main elements; better relationships, contractor's input into the design, and better risk management. According to Pheng et al. (2015), the early coordination between contractors and designers will reduce the construction error due to miscommunication since contractors are more aware of the key issues surrounding the project, these benefits are in fact arise from the Lean principle of eliminating the waste in the processes and thus reducing the cycle time.

Suppliers' and Customers' Relationship

Several authors emphasized on building and maintaining solid long-term relationship with suppliers as an essential factor for Lean system as it will reflect positively in supplier performance (e.g. Nordin et al, 2012; Shah and ward, 2007). Studies found that building relationship will result in suppliers being more cooperative and committed to maintaining a high quality (Nordin et al, 2012). On the other hand, Lean concept focuses on creating value for customers, hence, it is important to building relationship with Customers in order to have their support for the Lean program. Within Lean Construction context, suppliers include subcontractors and material suppliers, while Customers refer to Consultants and Owners. Two sub-factors were considered here, namely: building relationship with Suppliers, and building Relationship with Customers.

Suppliers' Quality and Reliability

Supplier's Quality is critical in Lean System (shah and Ward, 2007), Quality here is supplying material or performing a subcontracted job at the right time and in proper quality without need for further inspection, performing this consistently is necessary to eliminate the process variability, this is regarded as Suppliers' Reliability. Suppliers' Quality and Reliability enables them to perform Just In Time (JIT) delivery (Found and Harrison, 2012), which a core elements in Lean since it reduces the process cycle time by eliminating the waste.

Contract

Traditional procurement methods and contract forms undermine the application of lean principles due to several reasons (Mossman, 2009) Cullen et al. (2005) stated that some contracts allow the parties to exert power over the second party which may create adversarial relations between them, creating transaction costs which is considered as wastes in the project. Mossman (2009) suggests that recent contracts such as PPC2000, Be, NEC3 are moving in the right direction. Kim and Park (2006) suggested Contract as one of the main themes for successful implementation, while Porwal et al. (2010) found that contractual and legal issues is one of the main berries in Lean Construction implementation.

Table 1 below illustrates the factors under study as well as their underlying sub-factors. A total of 15 Factors (22 sub-factors) were proposed. Each sub-factor is considered a variable which requires further investigation in order to assess whether it's considered as Critical for the implementation or not.

Table 1: Factors (& sub-factors) under study

Factor No.	Factor	Sub-factor(s)
F1	Management Commitment & Involvement	▪ Management Commitment ▪ Management Involvement in Lean
F2	Management Leadership	▪ Management Leadership
F3	Employee Participation & Motivation	▪ Employees' Participation in improvements ▪ Employees' Motivation
F4	Training & knowledge	▪ Provide Lean Training courses ▪ Training to cover subcontractors and suppliers
F5	Skills & Expertise	▪ Hiring employees' who have knowledge in Lean
F6	Communication & Collaboration	▪ Effective Communication ▪ Cross-Functional Teamwork (Collaboration)
F7	Financial Capability	▪ Financial Capability of the company
F8	Process Documentation & Standardization	▪ Process Documentation ▪ Standardization
F9	Strategy & Planning	▪ Develop Lean Implementation Strategy ▪ Planning the implementation
F10	Benchmarking	▪ Benchmarking with Top leading companies
F11	Organizational Culture	▪ Culture Change
F12	Contractor Involvement	▪ Early Contractor Involvement in Design Stage
F13	Suppliers' Quality	▪ Quality & Reliability of Suppliers
F14	Suppliers' & Customers' Relationships	▪ Building Relationships with suppliers ▪ Building Relationships with Customers
F15	Contracts	▪ Adopt Contract forms that supports Lean

Research Method

In order to answer the research questions, following the literature review, a questionnaire has been designed and distributed to collect data for this exploratory study. The questionnaire consists of two sections in addition to a brief description about the study. The first section aims to generate general and demographic information about the participant, as well as understand the extent to which Lean practices are used in UAE. The

second section aims to identify the perception of the respondents on the factors being critical for the successful implementation. Each sub-factor (in Table 1) was represented by a single question in order to measure the respondents' agreement on whether he/she considers it as critical. Consequently, a total of 22 questions were developed for section-2. The questionnaire is kept concise and short in order to ensure a high response rate.

The Likert type of measurement has been used in the second section in order to assess the agreement of the respondents in considering a particular item as critical, the respondents were asked to answer based on a 5 measure scale: (5) strongly agree, (4) agree, (3) Neutral, (2) disagree, (1) strongly disagree. The questionnaire has been published on Survey Monkey as an online survey, and the survey has been sent out through direct emails to professionals and top managers working in the construction field. This method allows the respondents to research and read about Lean Construction methodologies and have a general understanding before answering the questionnaire. The survey was sent to 428 personals, and 226 questionnaires were returned (response rate 52%). Only 212 questionnaires were completed and hence can be used for the analysis.

Results & Analysis

The responses were entered into SPSS software. First, The Reliability test was conducted to measure the internal consistency of the 22 items. The Cronbach's alpha value for the total scale was 0.76, indicating an acceptable degree of internal consistency among the items on the scale.

Lean Construction in UAE

Frequency analysis was used to determine the sample characteristics of the respondents. Figures 1a and 1b below illustrate the distribution of the respondents according to: the Position of the Respondent, Classification of the Contractor, Field of work, and the respondent's experience in construction.

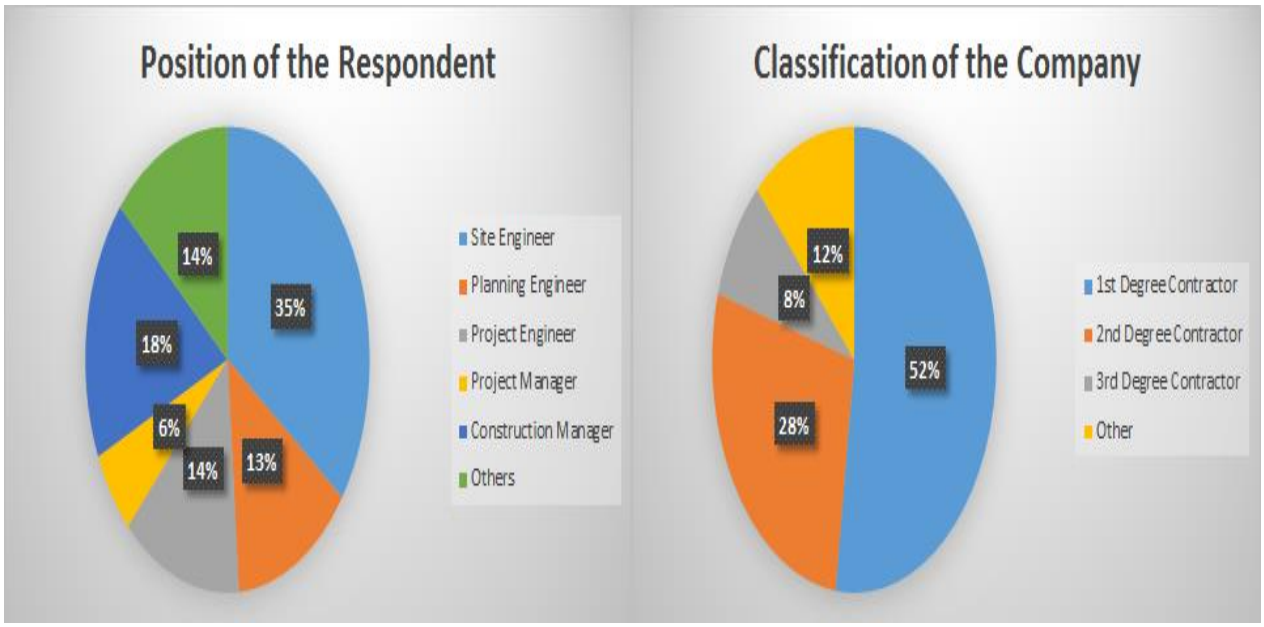

Figure 1a: Demographic Distribution of the Sample

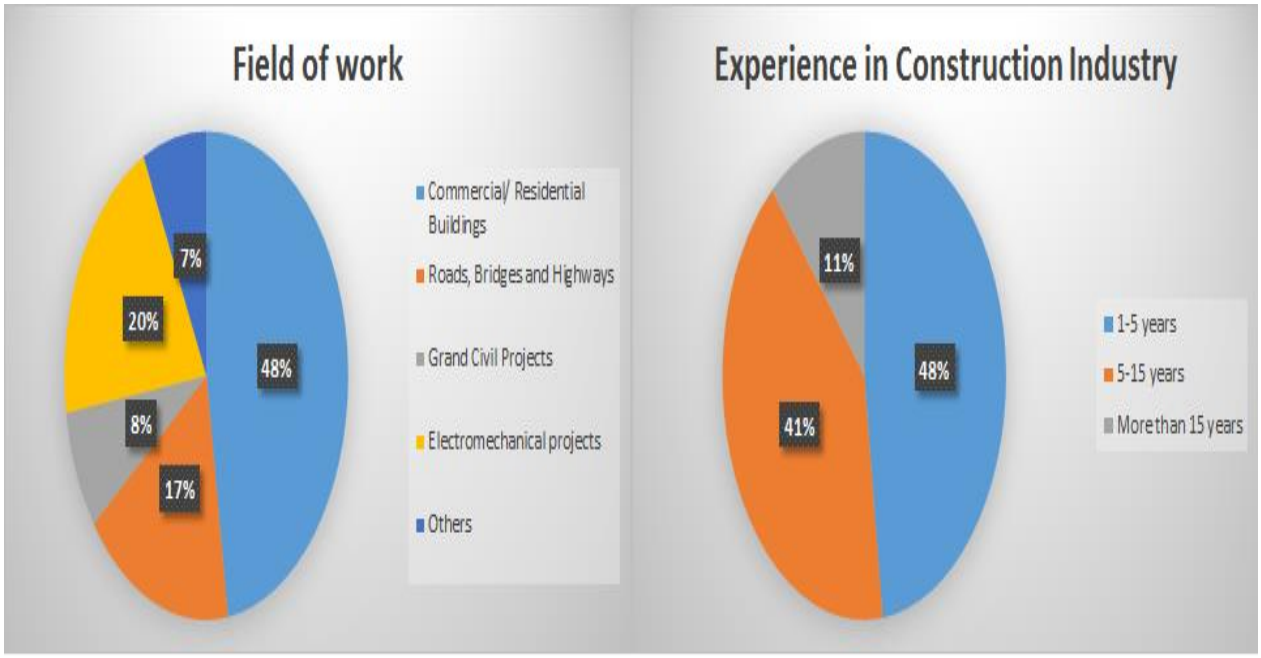

Figure 1: Demographic Distribution of the Sample

Figure 2 below depicts the extent to which Lean Construction practices are used by UAE Construction companies. Nearly a quarter of the respondents were found to be unfamiliar with Lean Construction, whereas almost half of them reported that while they are familiar with Lean Construction, they have not used Lean techniques in their projects. Only 28% of the surveyed companies claim to be familiar with and were using lean techniques, with almost 90% of these companies being 1st Degree Contractors, and nearly 60% working in commercial and residential buildings. This matches the findings of Al-Aomar (2012) study in Abu Dhabi Construction Industry.

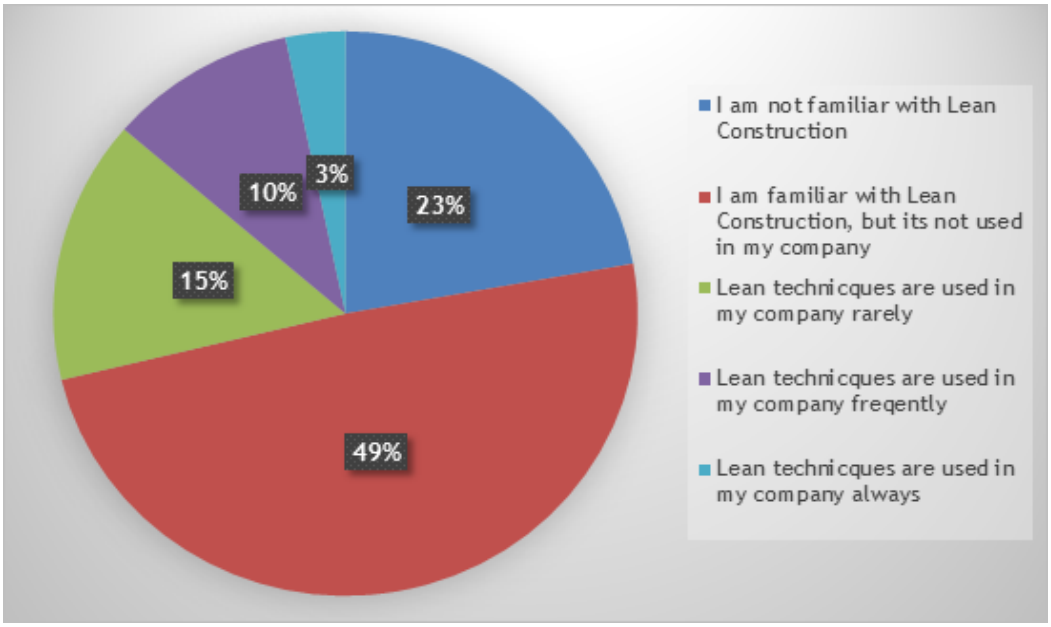

Figure 2: The Extent of Using Lean Techniques in UAE Construction Industry

Relative Importance Index

One-sample t-test was carried out to identify whether the proposed factors under study are considered critical for the successful implementation of Lean Construction as perceived by the respondents. The test is used to determine whether the mean score from the sample is statistically larger than a neutral value (number "3" in this questionnaire), this is because "larger" here indicates the agreement of the respondent on considering a particular item as critical. Moreover, the Relative Importance Index (RII) was used to determine the factors ranking based on their relative importance.

Table 2 below shows the Mean, RII, and statistical significance results for the proposed factors under study.

Table 2: Mean, t-test, RII for the Factors under study

Factor No.	#of sub-factors	Factor	Mean	Sig. (one tailed)	RII
F1	2	Management Commitment & Involvement	4.19	0.00	0.838
F2	1	Management Leadership	3.81	0.00	0.761
F3	2	Employees' Participation & Motivation	4.01	0.00	0.831
F4	2	Training & knowledge	3.72	0.00	0.744
F5	1	Skills & Expertise	3.66	0.00	0.732
F6	2	Communication & Collaboration	3.70	0.00	0.740
F7	1	Financial Capability	3.06	0.183	0.611
F8	2	Process Documentation and Standardization	3.61	0.00	0.722
F9	2	Strategy & planning	3.87	0.00	0.774
F10	1	Benchmarking	3.11	0.054	0.622
F11	1	Organizational Culture	4.16	0.00	0.835
F12	1	Contractor Involvement	3.98	0.00	0.796
F13	1	Suppliers' Quality	3.79	0.00	0.758
F14	1	Suppliers' & Customers' Relationships	3.64	0.00	0.728
F15	1	Contracts	3.77	0.00	0.757

The results were significant at α=0.05 for 13 of the proposed factors (F1, F2, F3, F4, F5, F6, F8, F9, F11, F12, F13, F14, and F15), hence, we have enough evidence to infer that

most of the contractors considered these factors to be critical for the successful implementation. This matches the findings in the literature as previously discussed. Consequently, we can consider these 13 factors to be the CSFs for Lean Construction.

On the other hand, the results for factors F7, and F10 were not significant at α=0.05 leading to conclude that most of the contractors didn't consider these factors to be critical for the success. It can be noticed that contractors didn't consider the "Financial Capability" of the company to be critical for the successful implementation which might be due to the fact that some tools and techniques don't require significant investment, and the company can adopt them despite its financial situation. "Benchmarking" was not regarded as critical either, which doesn't go in line with the findings from Ballard et al. (2007) study.

Table 3 below illustrates the 13 CSFs ranked according to their relative importance. According to the respondents, Management Commitment & Involvement is the most important CSF, which goes in line with the previous related studies, followed by Organizational Culture as a key factor as well as engagement and motivation of employees. Whereas Building relationships with suppliers & customers, and processes documentation & standardization were not regarded a high importance as such.

Table 3: Ranked CSFs

Rank	Factor
1	Management Commitment & Involvement
2	Organizational Culture
3	Employees' Participation & Motivation
4	Contractor Involvement
5	Strategy & Planning
6	Management Leadership
7	Suppliers' Quality
8	Contracts
9	Training & Knowledge
10	Skills & Expertise
11	Communication & Collaboration
12	Suppliers' & Customers' Relationship
13	Process Documentation & Standardization

Conceptual Framework

A Conceptual Framework has been developed which represents a more simplified, yet, comprehensive view that encompasses the 13 factors which were discussed and considered to be critical for the implementation. These CSFs were categorized into four main themes called "Constructs", namely: Managerial, Organizational, Structural, and External Factors, Figure 3 below illustrates the Conceptual Framework for Lean Construction CSFs.

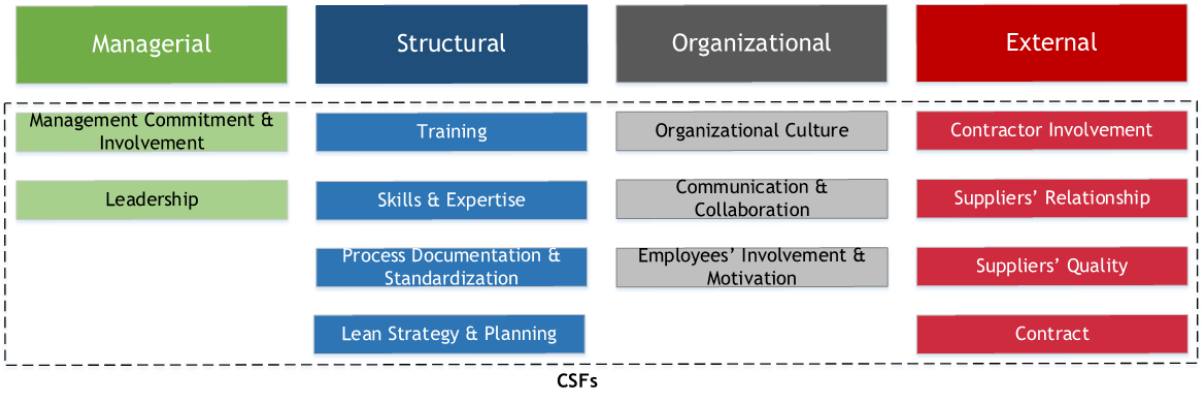

Figure 3: Conceptual Framework for Lean Construction CSFs

Managerial

The Managerial elements are related to top, middle and site management. Management support is crucial to the success of the program, this includes the awareness of the Lean methodology and its benefits, their commitment to the improvements, and their involvement in the program by supervising, allocating resources and funds, and formulating strategies and goals. Strong Leadership is necessary to enforce the change and creating a supportive working environment where employees are recognized and encouraged.

We cannot stress enough on the importance of this construct in the entire lean implementation journey, since several studies reported that it is because of Managerial related issues, Lean Construction has ended with failures.

Organizational

This encompasses the "Internal Soft Issues" related to the implementation. Ensuring the engagement and participation of all employees in the lean program is a key element which in return will reflect in their attitude towards change, creating a healthy organizational culture that supports and encourage the change and improvements, and in which the employees' resistance to change is minimized.

Moreover, ensuring effective communication and collaboration between employees and departments and team work will streamline the operations, thus, reducing the waste and improving the cycle time.

Structural

This Construct includes elements related to the technical side of the implementation and considers the "Internal Hard Issues" of the implementation. First by providing training to top employees in the organization, and hiring new employees taken into consideration their expertise and knowledge in Lean practices, by doing so, the organization ensures the availability of the right skills and expertise to support the implementation. The appraisal methods in the company should capture some "Lean Performance measures" by including individual performance criteria related to the implementation of the Lean in the employees' appraisal.

On the other hand, Lean places a huge emphasis on processes, this entails building an efficient Process Management System through process and procedure documentation, Quality Management System (QMS) based on ISO9000 is recommended in this regard, then by standardizing the site activities.

Finally, it is essential to formulate and document a Lean Strategy that specifies the type of lean and tools to be applied, the plan and scope of implementation, as well as the methodology of implementation including allocating adequate resources and funds.

External

This construct includes elements related to other parties beyond the organization boundaries. The procurement strategy should be built around partnering between contractors, consultants and different suppliers. This entails building strong relationship with suppliers and subcontractors and keep them in proximity, working together with them to enhance their quality, as well as choosing the right suppliers based on certain criteria. Moreover, Contractor Involvement has been regarded with great importance. Finally, companies should consider adopting new forms of lean oriented contracts such as PPC2000, Be, NEC3.

Staircase Roadmap

Building on the Conceptual framework and the identified CSFs, a preliminary "Staircase Roadmap" has been proposed to guide the construction managers to implement lean in their projects. It represents a "Step by Step" approach in Lean implementation taken into consideration the previously discussed elements.

Figure 4 below shows the staircase roadmap for Lean Construction Implementation, the roadmap suggests that Lean should be diffused through 12 steps, with continuous monitoring of a set of metrics in order to make sure the Lean goals are being achieved with noticeable improvements. Al-Aomar (2012) proposed five Lean Construction Key Performance Indicators (LC-KPIs), namely: Quality, Speed, Cost, Waste Index, and Value index. Hence, the roadmap suggests that these KPIs should be monitored throughout the implementation by setting a LC-KPIs baseline and continuously measure the performance accordingly.

The Roadmap suggests that Lean tools should be implemented as part of a broader perspective based on lean philosophy, rather than an isolated implementation of tools and techniques. According to Bhasin and Burcher (2006), Lean transformation needs to be seen as a journey, and not as a tactical or technical process.

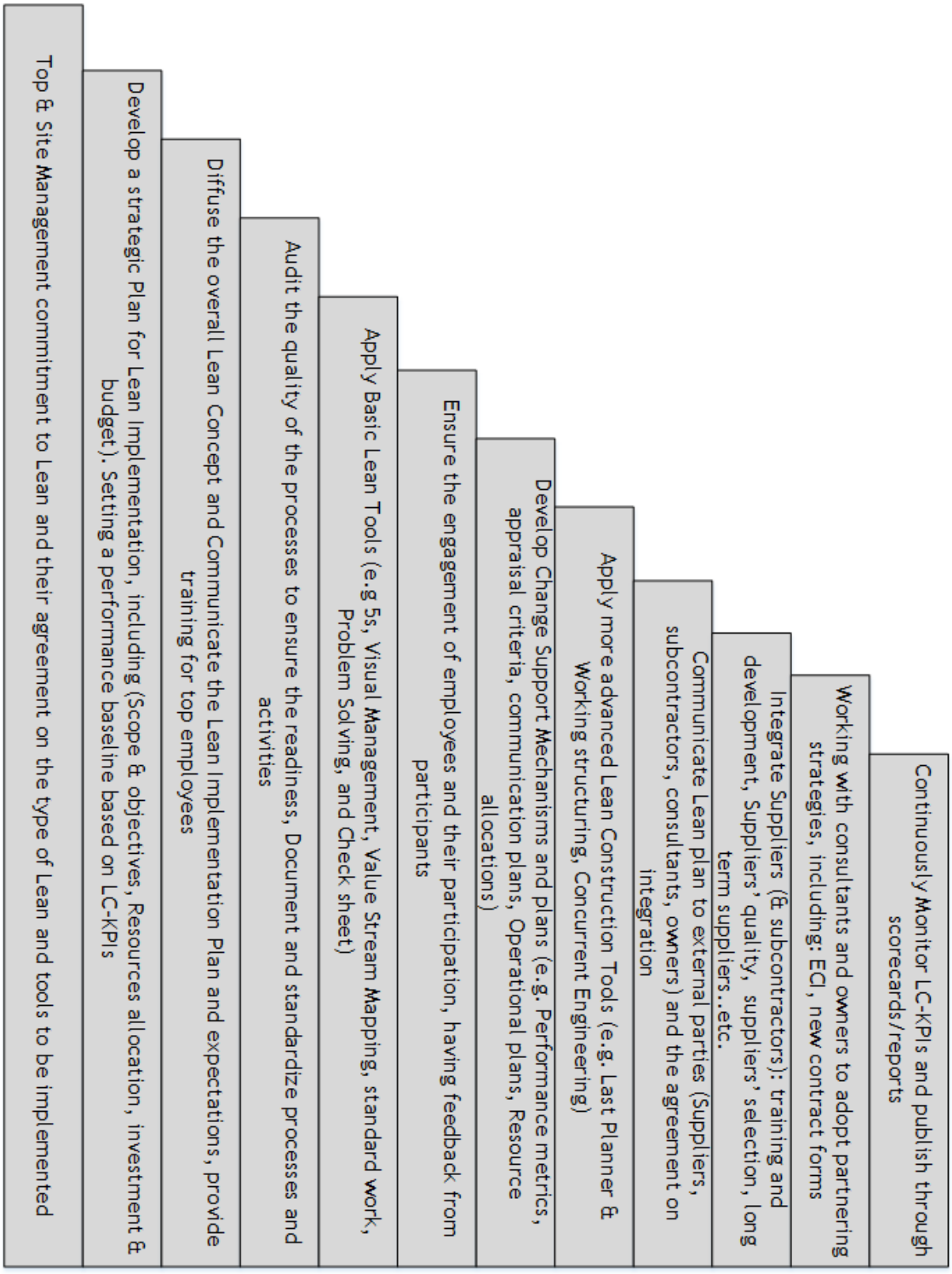

Figure 4: The Lean Construction "Staircase Roadmap"

Conclusion

This study identified 13 factors that are considered critical for the successful implementation of Lean Construction, the factors were then summarized into four main constructs which represents the pillars of the proposed Conceptual framework that captures all necessary elements and comprehensively answers the first research question. To put these CSFs into action and to answer the second research question a preliminary Staircase Roadmap was proposed. The value of this study lies in establishing a comprehensive Framework that provides the foundation for successfully implementing the Lean in construction companies. Moreover, the staircase Roadmap shows that the adoption of Lean should be from a strategic perspective rather than fragmented and isolated application of Lean tools.

The study found that Lean Construction practices are not widely used in the UAE where only 28% of the surveyed companies were found to be familiar with and were using lean techniques.

The limitation of this research arises from the inherent statistical nature of the research method, the quantitative method is subject to statistical errors which cannot be controlled. The credibility of the research results and findings is also dependent on the accuracy and reliability of collected data from construction companies. Furthermore, the idea of categorizing the CSFs into four Constructs in the Conceptual Framework can be judgmental as it only reflects the authors' subjective opinion in building the Framework.

In terms of future works, we recommend extending this study by empirically exploring the proposed CSFs through case studies and interviews with experts and practitioners as well as conducting survey analysis in other regions in the world. Potential modifications or additions might arise based on the results. Additionally, the Conceptual Framework can be used as a basis to develop a Lean Construction Readiness Framework to assess the capability of the company to adopt Lean Construction prior to the implementation. Finally, the proposed preliminary Staircase Roadmap can be further developed to establish a detailed Roadmap that guides the construction companies throughout their Lean journey.

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