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Kuwait's Construction Sector: Investigating the Industry's Conformance to Lean

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Abstract

Question: What are the current behavioral features of the local construction sector? Which practices can be improved to overcome the low productivity of the construction sector in Kuwait? What is the present Lean Construction (LC) behavioral conformity levels of the Kuwaiti construction sector? How resilient is the sector in adapting LC?

Purpose: The aim and purpose of this research is limited to investigating the extent of LC application in behavioral practices using a lean assessment tool developed by Diekmann et al. (2004) to be able to quantify and analyze both the conformity and non-conformity levels to LC, and finally determine the sector's readiness in adapting LC more extensively.

Research Method: A mono method quantitative methodology was deployed to collect and analyze data from 55 self-completed surveys.

Findings: The research indicates that the sector exhibits low to moderate levels of conformity to LC in its behavioral aspects of operations, management, and organization. Moreover, the highest scoring main LC principle is Continuous Improvement/Built-in-Quality, and Culture/People is the lowest. This suggests that the sector is familiar to some degree to LC and has good potential to further implement it.

Limitations: The survey was distributed to respondents in Kuwait using a non-probability sampling technique, the snowball sampling method. The results are solely based on the feedback given by the participants which might cause some bias in the results.

Implications: The paper highlighted the current behavioral shortcomings the sector is projecting in conjunction to the ideal LC practices, LC levels of spread and application, Lean adaptability levels, and have created a benchmark about these points for upcoming research of Kuwait's construction sector.

Value for practitioners: The Kuwaiti construction sector can utilize the findings to develop and/or enhance their operations, management and organization approaches using Lean thinking and principles of practice to increase their productivity, competitiveness, overcome the common construction predicaments and are meeting

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customer's requirements in cost, quality and timely delivery.
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Paper type: Case study.

Introduction

The state of Kuwait has set forth Vision 2035, a development plan that has the purpose of elevating the local living and business standards to higher levels (GSSCPD 2020). A nationwide vision and mission that mandates local economic sectors to operate and produce to obtain its "strategic developmental goals", and the construction sector is a key player in delivering this achievement (MOFA 2021). The country is aiming to achieve global recognition with its ambitious development projects, but it seems to be trembling in the pursuit of that achievement. The peculiarities of the construction industry are unique to its nature, full of challenges and ambiguities that make it only on the rarest of occasions straightforward and easy (Koskela 1992, Ballard and Howell 1998). Late project and task completions, low productivity rates and non-collaborative working environments are few of the byproducts the current construction management approaches are incapable of overcoming (Ballard 2000, Hussin et al. 2013, Shah 2016, Soliman 2017, Al-Adwani et al. 2018, Kavuma et al. 2019).

These phenomena are evident on global and local scales. Recently, it was reported that Vision 2035's plan is behind schedule, and from the 26 projects of the infrastructure division more than half of them are experiencing delays according to the planned strategy in the third quarter of 2019/2020 fiscal year (GSSCPD 2021). In their initiative about Kuwait, Al-Adwani et al. (2018) concluded that the lack of new managerial methods' application, lack of communication, and long waiting times are directly related in hindering projects' timely delivery. Al-Adwani and Fleming (2019) explored the local construction sector's conditions revealing that waiting times were the highest-ranking factor, followed by improper talent exploitation, then frequent defects in reworks as common non-value-added activities that give rise to projects that are behind schedule (ibid.). Koskela (2000) and Shah (2016) agree that the traditional methods are becoming a liability to newer projects that are becoming more complex.

Current and future investments in Kuwait's construction sector carry a large magnitude in cost, quality and stature for the country, emphasizing the need to reform now more than ever (Howell and Koskela 2000, Forbes and Ahmed 2011). It is then crucial to study and investigate the current trends and practices of the industry and identify alternative ways to mitigate frequent projects' predicaments. One such trend is Lean Construction (LC) (Mossman 2009, AlSehaimi et al. 2014, Ozorhon et al. 2014, Nowotarski et al. 2016, Watfa and Sawalha 2021). In Kuwait however, Lean's penetration into the industry is neoteric and not much research has been conducted in trying to understand LC's diffusion and applicability in the Kuwaiti construction market.

Lean Construction

Mossman's (2018) contribution spotlighting the continuous dilemma of defining LC is commended. After completing his endeavor in answering and pinpointing a holistic, concise, straightforward answer in defining it from prominent LC figures and publications'

investigation, he defined it as "a practical collection of theories, principles, axioms, techniques and ways of thinking that together and severally can help individuals and teams improve the processes and systems within which they work." (ibid, p.1249). Theories for example that are conceptualized in Ballard's (2000) Last Planner System® (LPS®), that builds on actual commitment of what can and will be done from the last line workers to boost productivity and quality of jobs performed whilst reducing work variations (Warid and Hamani 2023). Principles focusing on reducing the share of non-value-adding activities, and cycle time (Koskela 1992, p.16), and pursuing perfection (Womack and Jones 2003 - pp. 15-90, Malvik et al. 2024). Tools and techniques that translate these principles into actual practical actions in the working environment to enhance delivery, organization, enforce transparency, and create direct lines of communications (Tommelein and Weissenberger 1999, Gao and Low 2014). Philosophically, as Abdelhamid and Copeland (2022) summed it, to practice and be Lean the overarching realization is that improvement should be the goal within the complete structure of a project, inherently practiced in the life cycle of a project to create the value the customer is seeking. This does not exclude the current construction management approaches, rather complement them, refining them, and makes them serve a rather more noble and integral purpose towards the customer (ibid). These are clear, comprehensive, and all-inclusive descriptions of what being Lean means. The case study in this paper is designed to reflect and examine practices against this definition.

Globally, the advantages and positive effects of LC were verified in several cases (Senaratne and Wijesiri 2008, Andersen et al. 2012). In Brazil, cost reductions were greatly achieved when processes lead time was reduced and a more continues flow between activities was established (Aureliano et al. 2019). The impact of utilizing Lean management tools – JIT and 5S for organization – on an ongoing construction project in Poland had positive impacts in accessibility, space availability, and monthly costs savings (Nowotarski et al. 2016). In a two-part research that included a systematic literature review on published papers of 26 case studies of projects where the LPS® was applied (Ballard 2000), the added benefits of the tool during its application were gathered and grouped. As reported by the researchers, the most frequent benefits experienced from implementing LPS® were "increased workflow reliability", "reduced project delivery or production time", "improved supply chain integration", and "improved communication" (Fernandez-Solis et al. 2013, p. 356). In Saudi Arabia, another effort was initiated in testing benefits of LC using the LPS®, which eventually proved the beneficial qualities it possesses in elevating the projects overall performance, stakeholders worked more collaboratively, and as a result common delaying factors became uncommon, assuring a precise, uninterrupted delivery of the project (AlSehaimi et al. 2014).

In Kuwait however, Lean's penetration into the industry is neoteric, and not much research has been conducted to understand LC's applicability and diffusion in its construction sector. Authors Alazemi (2013), Al-Najem et al. (2013), and Al-Adwani and Fleming (2019) took pivotal initiatives investigating LC in the region, however, they did not investigate the concept holistically, and in its practical application in the construction field. For example, Alazemi's (2013) research in assessing Total Quality Management (TQM) and Quality Management (QM) application in the Kuwaiti construction sector concluded that the targeted population exhibited little knowledge and little usage of TQM and is mostly concerned with the International Organization for Standardization (ISO) (ibid.).

Moreover, Al-Adwani and Fleming (2019) study in investigating the spread of Lean determined that its spread is low. Although their research focused on identifying the current challenges in the industry as an objective to their research and advocated the importance of exercising Building Information Modeling (BIM) and LC widely to overcome them, no research was conducted in evaluating the extent of Lean behavioral practices in the same context with relation to LC's principles. In another research, Al-Najem et al. (2013) completed an investigation of Lean implementation and the readiness to adhere to LP philosophies in Kuwait for small and medium sized enterprises. Their results yielded that the industry is "not very supportive" in adapting Lean into their quality practices (ibid., p. 303). However, this study's targeted population was the manufacturing industry, not construction.

Organizational Behavior: Its Merits and Values

Organizational Behavior (OB) is defined as "the study of human behavior in the workplace, of the interaction between people and the organization, and of the organization itself" (Griffin and Morehead 1995, cited in DuBrin 2019, p. 3). In this field individuals, groups and organization systems are units of analysis that contribute to this field, and it stems from the combination of scientific disciplines (Robbins and Judge 2016). In investigating or explaining certain behavioral aspects, theories or phenomena, a researcher can conduct systematic research requiring them to collect attributable data of the test subject to "explain, predict, and control behavior" (Ivancevich et al. 2014, DuBrin 2019, p. 3). In addition, once harvested, learning about the behaviors of the people will leverage the chances in boosting individuals', groups', or organizations' six criteria of effectiveness, which include "quality outputs, productivity metrics, efficiency measures, satisfaction, adaptiveness and development" (Ivancevich et al. 2014, pp. 12-14). Utilizing an Evidence-Based Management approach would act as a supporting mechanism in reactions and decisions the manager in position feels the need to execute (Robbins and Judge 2016). An appraisal that is in accordance with describing how top management's involvement and commitment is certainly an important factor in applying LC in a company or an organization (Sarhan and Fox 2013, Ward 2015, Sarhan et al. 2016, Enshassi et al. 2018, Albalkhy and Sweis 2020).

In a group setting, its individuals would demonstrate over time common norms, behaviors and attitudes that are aligned with what this group considers acceptable to the situation or inhabiting environment (Robbins and Judge 2016). This develops over time of interacting and coexisting, adjusting to a degree of normality within this group (ibid.). Conforming to the norms, is then a process of adjustment, how much an individual is conforming to a set standard, believe or behavior (Ivancevich et al. 2014, Robbins and Judge 2016). To this inference, distinguishing a 'standard' behavior of LC then testing what the targeted group is conducting themselves against will "explain, predict, and control behavior" (DuBrin 2019, p. 3,Ivancevich et al. 2014).

Behavioral Conformity in Lean Construction

Scholars aiming to measure LC's spread became vital in explaining distinctive marks of each targeted cluster and as a great source of information (Diekmann et al. 2004, Johansen and Walter 2007, Al-Aomar 2012). With respect to LC behaviors and what constitutes their counter actions, a Lean Assessment Tool was developed by a team of

researchers from Austin, Texas to expand on the mentioned ideas. Utilizing this instrument would yield beneficial outcomes for Kuwaiti construction sector. These were realized by multiple studies conducted in different contexts, for example in assessing self-claimed Lean practitioners, and demonstrate their proximity to being Lean in their organizational and operational practices, raising awareness of LC and its behavioral practices for the target population, yield results that describe the readiness of the construction industry in adapting LC in the future, highlight the areas of concerns that are widely affecting the productivity aspect of the construction industry – for example in Kuwait, highlight areas of improvement the construction sector organizations can follow to increase their performance (Tezel and Nielsen 2013, Mukabana et al. 2015, Al-Adwani and Fleming 2019, Aghayev et al. 2020).

Diekmann et al. (2004) and his team of researchers developed a Lean Assessment Tool – in a form of a questionnaire – based on five LC principles. These were Customer focus, Culture/People, Workplace Standardization, Waste Elimination and Continuous Improvement/Built-in Quality (ibid.). The first principle, Customer Focus, inhabits five sub-principles that shed light on the importance of identifying what the customer is asking for and the ability to fulfill their needs, and simultaneously, distinguish the value in what the customer is looking for. In addition, to possess the capacity to be "flexible" and "adaptive" to any changes that may occur during the process without jeopardizing the product's quality (Diekmann et al. 2004, pp. 92-95). The second principle, Culture/People, encompasses four sub-principles that are translated as Lean behaviors. An example for such is to provide training for the employees, motivating employees to take on more responsibilities and empowering them (Diekmann et al. 2004).

The third, Workplace Standardization and Organization, refers to tools and methods such as "Poka-Yoke", 5S, Visual Management and the creation of a structured working environment to make the working site consistent and uniform, which are presented in five sub-principles (ibid. pp. 98-101). The fourth, Waste Elimination, deals with production flow and the elimination of bottlenecks in the production processes, reducing flow variability whilst minimizing construction waste (Diekmann et al. 2004). This principle is divided into fifteen sub-principles, grouped in three aspects of Process Optimization, Supply Chain and Product Optimization. The fifth principle, Continuous Improvement/Built-in Quality, dictates that the involved parties in all aspects of the working environment and projects must embrace a common goal of finding better solutions to every task or activity, whether to add quality, reduce cost and/or delivery duration. Lessons learned and feedback loops are the basis of better outcomes in this principle. The fifth principle is sectioned into four sub-principles (ibid.).

Each question from the assessment tool allows the participants who are undertaking this questionnaire to evaluate a particular behavior – total of 52 questions – if it is Lean or non-Lean using a Likert scaling system (see Figure 1). The intention was when a respondent reads both statements, they should not feel any urge to choose Lean behavior, rather, the reader must answer with full confidence to what exactly reflects the situation they are dealing with (ibid.). Thus, both opposite statements were made as attractive to the reader as possible, "Wording was selected that made both statements seem favorable so that the respondent would be forced to choose the one that more accurately described his or her company" (Diekmann et al. 2004, p. 42). In essence, the researchers' goal from this tool was to give the ability for the respondents to measure their current operational practices

and working behaviors in conjunction to LC principles and the level of conformity they hold, this included self-proclaimed lean practitioners and/or non-lean practitioners too (ibid.). This is contrary to Nesensohn et al. (2016) because their measurement tool is designed for organizations either in the early stages of Lean implementation or want to exercise it more.

The research team's target group was the construction field. In return, they had to guarantee the questionnaire is relevant to all hierarchal levels that a construction company, organization, or project usually includes. This is concluded from their case studies with questions covering organizational, project management, and crew levels, given that Lean is applicable to all three of them (Diekmann et al. 2004).

Behavioral Practice: Error Proofing Devices		
Non Lean Behavior	Measurement Scale	Lean Behavior
Materials arrive on-site without directional marks or any specific assembly instructions, and require communications with the supplier, engineer, or fabricator to assemble	N/A (1) (2) (3) (4) (5) (6) (7)	Methods for site assembly show piece marks or other methods to assure a "one way only fit" such as color coding, numbering, etc.

Figure 1. Example of one item from the Lean Assessment Tool[2]

Lean Conformance Case Studies

Tezel and Nielsen's (2013) paper investigated the conformity levels of the Turkish contractors to LC in addition to its spread amongst them. Their paper revealed that it is not well known, but their conformity levels were high, indicating that they were possibly applying Lean principles with different terminologies, and are susceptible to apply lean it and easily so. They deployed a questionnaire that adopted Diekmann's model, describing it as a well-structured model, easy to understand, addresses the operational level of LC application and avoids Lean terminologies in its questions to some degree, which may confuse readers who are not familiar with it (Tezel and Nielsen 2013). Similarly, Mukabana et al. (2015) efforts were targeted in Nairobi, Kenya, studying Lean conformity levels of the building contractors in the region. They have concluded that the conformity levels amongst the sampled participants were high, indicating the similarity of their current working practices and behaviors to Lean's, although LC methods were considered relatively new to that region (ibid.). In the Middle East, Sweis et al. (2016) conducted research to increase the awareness of LC in Jordan by assessing the LC Conformance as the main objective. Using a structured survey that adopted Diekmann et al. (2004) model the data showed that none of the surveyed contractors were committed to Lean managerial philosophies beforehand, however, they demonstrated similarities in its principles regarding its behavioral practices at the operational level (ibid.).

Ultimately, the objective is to unveil unexplored truths and facts about Kuwait's construction sector's behavioral practices in conjunction to Lean's to append new knowledge to the field of project management. Conducting this study will reveal the levels of conformity and readiness to LC the sector is exhibiting. This is plausible by utilizing a reliable and a valid instrument that would adapt to Diekmann's et al. (2004) model of Lean assessment. In addition, an examination of behavioral aspects will aid the industry in utilizing Lean methodologies now and in the future, because of the close correlation

[2] Excerpted from Diekmann et al. (2004, p. 279)

between behavior in explaining, predicting, controlling and leveraging better performance outcomes in individuals, groups and organizational systems, such as the professionals and working entities in the construction value chain (DuBrin 2019).

Methodology

The research is a cross-sectional study to uncover the truths of the reality that is currently existing in the organizations. A survey was distributed between March and April of 2021 (Burrell and Morgan 2016 cited in Saunders et al. 2019). The population is the working professionals in the construction sector and target population is the working individuals in the State of Kuwait. In addition, they must be currently employed, have been practicing their professional credentials in the construction field and are involved in the operational or organizational aspects in their duties as contractors, general contractors or sub-contractors, thus owners were excluded from the population since they usually play a role of passive funders, and the investigator is aiming to reflect how the day-to-day operations are happening (Saunders et al. 2019, Ive and Gruneberg 2000). Secondary data from news articles and reports, conference proceedings, published journal articles, dissertations and books to gather related information for the researcher to critically review, discuss, synthesize and conclude as relevant to the topic (Saunders et al. 2019). For example, the appropriateness of how a questionnaire with a correct design and purpose – Diekman's model and its reproducibility as evident in similar papers – will satisfy the research's objectives (Saunders et al. 2019). The primary data is descriptive in its nature collected using a self-completed questionnaire. To reflect the findings in achieving the research's aim and purpose, numerical data were used to allow descriptive and inferential statistical analyses (ibid.).

Questionnaire Design

The first part of survey is intended to collect categorical data of the respondents, for example years of experience, educational level, working sector, and LC knowledge. The second part has questions that require the respondents to give their perception of a subject behavior using a Likert scaling system, referred to as "Behavioral Variables" (Saunders et al. 2019, p. 514). It will then be presented in a numerical manner to enable quantitative data analysis (ibid.). This part will be adopted from Diekmann's et al. (2004) model, since it holds good reliability scores – above 0.7 in a Cronbach Alpha test result – and was used by multiple studies, making it valid to this research's purpose (Saunders et al. 2019).

To make the questionnaire accessible, understandable, easy to follow and relatable to the respondents, sub-principles that are represented in more than one question were combined in a critical manner to make sure the concepts are still relevant and are making sense. Lean terminologies were also excluded as much as possible to reinforce this purposive redesign (Diekmann et al. 2004; Tezel and Nielsen 2013).

An iterative process was performed in designing the questions to guarantee the meanings of the original questions were not lost. The questions were designed in essence to reflect the concepts of Lean behavior by its principles and sub-principles and what is the counter behavior/action of each is. This approach is closely related to Tezel and Nielsen's (2013) model. Due to this similarity, the researcher will also use Tezel and

Nielsen's (2013) model as a referencing point in designing the questions. Albalkhy and Sweis (2019) examination of the Jordanian context adapted Tezel and Nielsen's (2013) model as well. Table 1 is an excerpt from part two of the questionnaire that is intended for the respondents to answer based on the closest proximity to their reality. See Appendix 1 for the complete survey. Finally, the respondents were given the opportunity to receive the results of the study by notifying the researcher of their interest.

LCC Level Measurement

The survey will yield data that will be collected, organized, categorized, then transformed to numeric values to be analyzed using IBM's SPSS Statistics™ and Microsoft Excel™. Initiating the statistical analyses will produce the primary data enabling the researcher to test hypotheses and draw inferences about the sampled population (Saunders et al. 2019). A measurement scale is developed to aid in the representation of Lean Construction Conformance (LCC) levels of the sampled population (ibid.) To measure the level of conformity that each response reflects, the LCC is treated as a weighted index (Saunders et al. 2019). The following equation was used to calculate mean LCC:

$$LCC\ \% = \frac{\sum S}{5 * n\ Res\ * Q} * 100$$

Where:

- ∑S = Summation of weighted answers to each sub-principle (real score)
- 5 = Maximum weight to each sub-principle
- n Res = Number of responses
- Q = Number of questions/sub-principles

Table 1. Sample from LCC Assessment Questionnaire Adapted from Diekmann et al. (2004)

Main Principle	**Sub-Principle 5: Staff Training**		
Culture/People	Non Lean Behavior	Measurement Scale	Lean Behavior
	Project participants are skilled enough to do their job. When required, training courses are done at their personal time only	(0) n/a (1) (2) (3) (4) (5)	Training courses are offered to develop more skills in people. When required, training courses are done during working hours

A scale of measurement for the corresponding results is necessary to develop to form a comprehensible discussion of the results and the resulting descriptive statistics of LCC variables – see Table 2 (Galang and Galang 2017, Saunders et al. 2019, Tezel and Nielsen 2013, Albalkhy and Sweis 2019).

Reliability and Validity

With its aim and objectives, using a survey questionnaire that was used in multiple previous studies satisfies validity concerns (Saunders et al. 2019). Pilot testing was used as a method to test the reliability and validity of the instrument in collecting what the researcher is intending to measure. In addition, the questionnaire's reliability and internal

consistency measurement will be tested using the Cronbach Alpha test (ibid.). The approach is like Diekmann's et al (2004), since each principle holds its own set of parameters and questions in the survey.

Table 2. Measurement Scale for LCC

Likert Scale	Range	In %	Description	Corresponding Score Range
1	1.00 to 1.80	20% to 36.2%	Extreme Conformity to Traditional Construction Methods and Behaviors	20% ≤ LCC Score ≤ 36.2%
2	1.81 to 2.60	36.2% to 52%	Moderate Conformity to Traditional Construction Methods and Behaviors	36.2% ≤ LCC Score ≤ 52%
3	2.61 to 3.40	52.2% to 68%	A Blend of Conformity to Lean Construction and Traditional Construction Methods and Behaviors	52.2% ≤ LCC Score ≤ 68%
4	3.41 to 4.20	68.2% to 84%	Moderate Conformity to Lean Construction Methods and Behaviors	68.2% ≤ LCC Score ≤ 84%
5	4.21 to 5.00	84.25 to 100%	Extreme Conformity to Lean Construction Methods and Behaviors	84.25 ≤ LCC Score ≤ 100%

Response validity from the sampled dataset is determined by a response criterion. If a sample response falls under one or more points, the sample will be considered as invalid and will not be included in the results and data analyses. The criterion is as follows:

- If a respondent answered the first question with "No" (Are you currently an active professional in the construction sector of Kuwait?) then this sample will be discarded.
- If there is a duplicate sample: Two sets of samples with identical answers for every question – 35 questions – one of the duplicates will be discarded.
- If there is an outlier: This group of responses were determined based on two criteria (Saunders et al. 2019):
  - Type I: If a respondent answered with "Yes" to question number 9 (Do you consider yourself as someone who practices any LC tools, methods and techniques at your current job?) even though he/she answered with "No" to question number 8 (Do you have any knowledge about LC or its tools, methods and techniques?). Then this sample will be discarded.
  - Type II: If the answers to the Likert scale questions' variables were extreme (i.e.: all the 26 questions were answered with highest score of 5, or lowest score of 1) then this sample will be discarded.

Findings

The total number of surveys completed was 72 (100%). 17 (23.61%) samples were discarded due to their invalidity. The final valid sample size is 55 (76.39%) responses. Out of the 55 responses, 25 (45.45%) of the samples of the dataset reported to have some knowledge about LC, its tools and methodologies whilst the remaining 30 (54.55%) reported the contrary (see Figure 2). From the 25 respondents who affirmed their knowledge of LC, only 11 (44%) of them answered with "Yes" and 14 (56%) answered with

"No" when asked if they are using/utilizing LC, its tools, methods or techniques (see Figure 3). Out of the 55 respondents, only 2 expressed their interest in the results and were given the opportunity to read and discuss it.

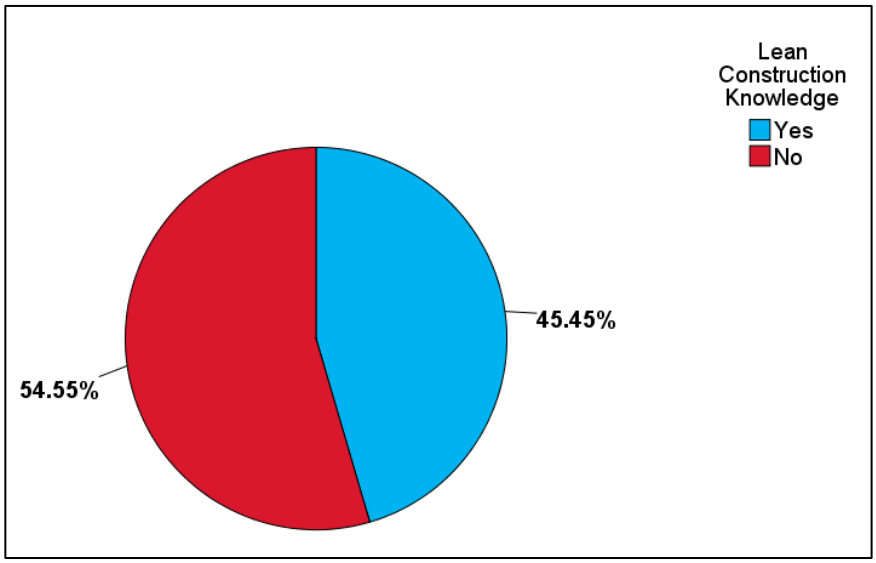

Figure 2. Respondents Distribution by LC Knowledge

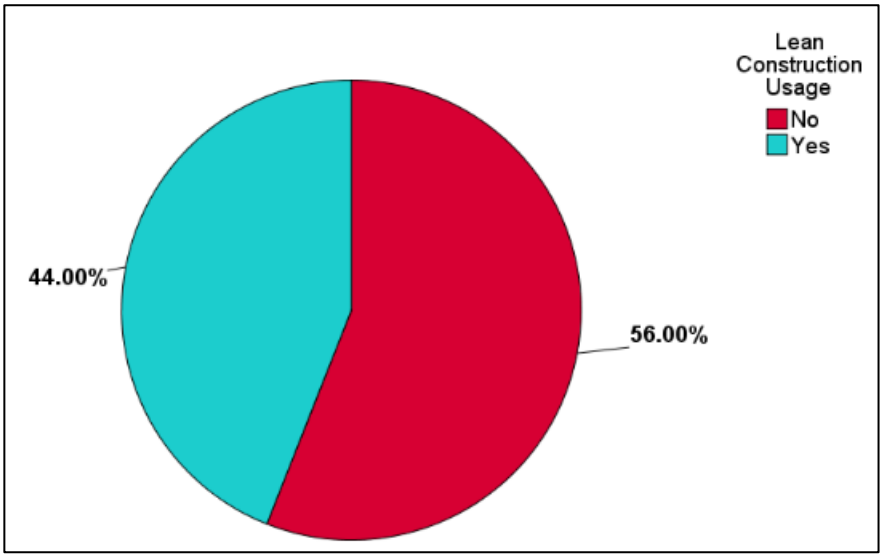

Figure 3. Respondents Distribution by LC Usage

Measuring LCC and Data Analysis

The measured mean LCC in percentage from the dataset is 68.48%, the median is 68.46% and the mode is 46.92%. From the histogram and frequency polygon graphs – Figures 4 and 5 – show a slight negative (left tailed) skewness of -0.144 and slightly platykurtic (negative) kurtosis of -0.064.

A test for normality is required to perform a parametric test, Kolmogorov–Smirnov (K-S) test for normality is used with a 95% confidence level ($\alpha = 0.05$) (Krieg 2014; Mishra et al. 2019).

The hypotheses parameters are set as follows:

H_0 = The dataset is normally distributed,

H_1 = The dataset is not normally distributed.

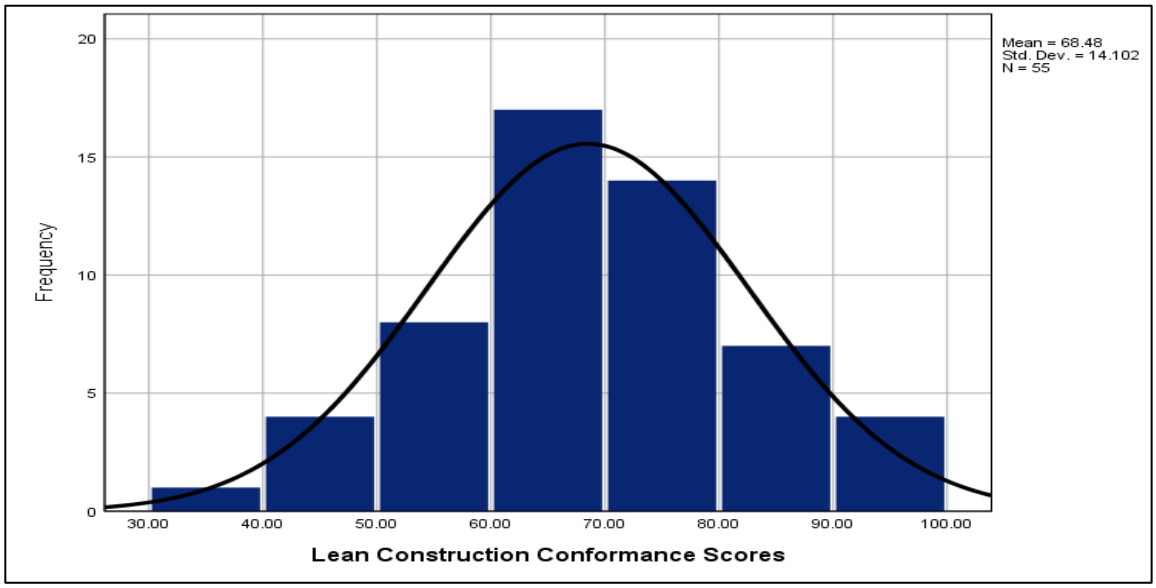

Figure 4. Histogram of the Complete Dataset by LCC Scores

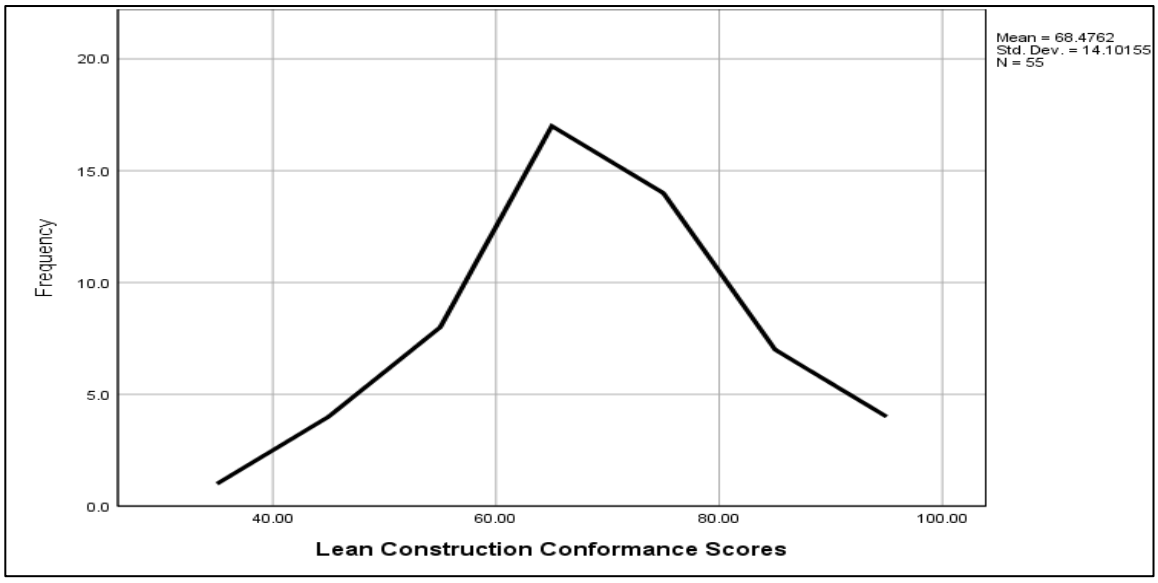

Figure 5. Polygon of the Complete Dataset by LCC Scores

K-S test result – Table 3 - of ρ-value = 0.200 > 0.05, meaning that the data of the LCC variable is not statistically significantly different – no reason to reject the null hypothesis – and its normally distributed.

With this illation, the researcher can determine the confidence interval of the sampled population mean LCC with a Student *t*-test – sample is larger than 30 and assuming a 95% confidence level – the following equation is used (McClave et al. 2018; Bluman 2014):

$$\overline{X} - t\frac{\alpha}{2}\left(\frac{s}{\sqrt{n}}\right) \leq \mu \leq \overline{X} + t\frac{\alpha}{2}\left(\frac{s}{\sqrt{n}}\right)$$

Where:

- α = confidence level
- t = critical t-value from t distribution table for a two tailed test
- $\overline{X}$ = mean LCC
- n = sample size
- s = sample standard deviation

Table 3. Normality Test Result of the Complete Dataset

	Kolmogorov-Smirnov[a]		
	Statistic	**df**	**Sig.**
Lean Construction Conformance	0.069	55	.200*

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

To determine the t-value from the table, the degree of freedom must be known. For our case, the degree of freedom (df = n–1 = 55-1 = 54) is not on the table, thus, degree of freedom of 55 was used (Bluman 2014, p. 790). Therefore, it can be said that the population's LCC with 95% confidence level is:

$$64.66\,\% \leq \mu \leq 72.28\,\%$$

The five main principles Customer Focus, Culture/People, Workplace Organization/Standardization, Eliminate Waste and Continuous Improvement/Built-in-Quality mean scores are 67.27%, 65.33%, 68.27%, 68.91% and 70.62%, respectively (see Figure 6). Table 4 shows the LCC distribution for each of the 26 sub-principles.

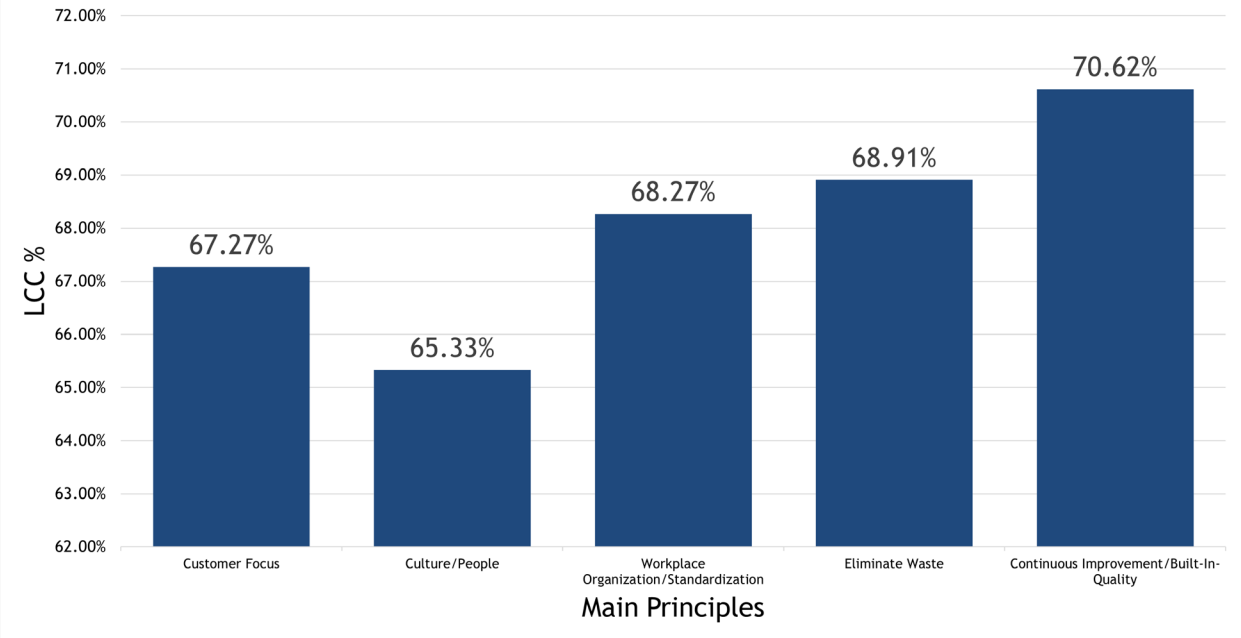

Figure 6. LCC Levels of Complete Dataset by Main Principles

Table 4. Lean Construction Conformance of the Complete Dataset by Sub Principles' Construct Distribution

Main Principle	Sub-principle	LCC % (Mean)
Customer Focus	Value Definition and The Customer	63.64%
	Organizational Resilience	71.64%
	Staff Resilience	68.00%
	Value Engineering	65.82%
Culture/People	Staff Training	60.00%
	Staff Appreciation and Collaboration	68.00%
	Management Proactivity	68.00%
Workplace Organization/Standardization	Site Organization	62.55%
	Rework Prevention Techniques	70.55%
	Visual Management	67.27%
	Movability & Availability	72.73%
Eliminate Waste	Work Plan Structuring - 1	78.18%
	Work Plan Structuring - 2	60.36%
	Work Plan Structuring - 3	66.91%
	Work Plan Structuring - 4	77.09%
	Work Plan Structuring - 5	65.82%
	Tasks Scheduling - 1	61.45%
	Tasks Scheduling - 2	66.91%
	Tasks Scheduling - 3	66.91%
	Work & Quality Assurance - 1	73.45%
	Work & Quality Assurance - 2	72.00%
Continuous Improvement/Built-In-Quality	Organizational Development	68.00%
	Quality Measurement - 1	67.27%
	Quality Measurement - 2	73.09%
	Quality Measurement - 3	73.82%
	Reaction to Defects	70.91%

Hypothesis testing if prior knowledge of LC would have any effect on the level of practicing of LC is performed, to understand whether the LCC will be affected if a respondent had prior knowledge about the concepts of Lean or not. This produces results that help in generalizing the findings of the whole population using a two-tailed independent-sample *t*-test of a confidence level of 95% ($\alpha/2 = 0.025$) (McClave et al. 2018; Adams and Lawrence 2019; Mishra et al. 2019; Saunders et al. 2019).

The hypotheses are as follows:

$$H_0 = \mu \text{ LCC of group 1} = \mu \text{ LCC of group 2}$$

$$H_1 = \mu \text{ LCC of group 1} \neq \mu \text{ LCC of group 2}$$

The assumptions for normality and homogeneity were tested and satisfied using K-S and Leven's test, respectively – see Tables 5 and 6.

Table 5. Normality Test Result of Group 1

	Kolmogorov-Smirnov[a]		
	Statistic	df	Sig.
Lean Construction Conformance of Respondents Who Are Knowledgeable of Lean Construction	0.143	25	0.198

a. Lilliefors Significance Correction

Table 6. Normality Test Result of Group 2

	Kolmogorov-Smirnov[a]		
	Statistic	df	Sig.
Lean Construction Conformance of Respondents Who Are Not Knowledgeable of Lean Construction	0.103	30	0.200*

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction.

With this illation, the first ρ-value (0.226) of the independent-sample t-test can be used as an indicator for the test result instead of ρ-value of 0.215 (see Table 7).

Table 7. Independent-sample t-test Results of Both Groups

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Lean Construction Conformance of Groups by Knowledge of Lean Construction	Equal variances assumed	0.623	0.434	1.225	53	0.226	4.65640	3.80114	-2.96772	12.28052
	Equal variances not assumed			1.256	52.606	0.215	4.65640	3.70830	-2.78281	12.09561

Discussion

Reliability Measurement

Concerning the validity and reliability of the second section of the questionnaire, the researcher adapted Diekmann's et al. (2004) model that has been used in multiple studies serving the same purpose in measuring LCC. Hence, the validity was not compromised (Saunders et al. 2019). In measuring the reliability of the same section and since the items are scale items, the Cronbach Alpha coefficient was calculated for each of the five sections/constructs. The tests show good internal consistency for sections Workplace Organization/Standardization, Eliminate Waste and Continuous Improvement/Built-in-

Quality. However, sections Customer Focus and Culture/People failed with an alpha coefficient of lower than 0.7 (ibid.) – see Table 8.

Table 8. Cronbach Alpha Test Results for Each Construct

Construct	Reliability Statistics		
	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	Items N
Customer Focus	0.65	0.657	4
Culture/People	0.457	0.475	3
Workplace Organization/Standardization	0.769	0.77	4
Eliminate Waste	0.809	0.814	10
Continuous Improvement/Built-In-Quality	0.767	0.765	5

Attributes Section

From the dataset, the concept of LC is apparent to be somewhat known. Approximately half of the surveyed individuals – 25 respondents (45.45%) – have reported to have some knowledge of LC, its tools, techniques and methods. This is a good indication that the population is being exposed and getting more familiar with the methods of LC in Kuwait. Admittedly, out of the 25 individuals of this research, less than half of them confirmed that they are currently applying Lean Construction's tools, methods and techniques in their working environment.

Lean Construction Conformance

In relation to the research's main question, LCC levels of the population were found to be between 64.66% and 72.28%, the mean at 68.48%, median at 68.46%, and the mode at 46.92%. This is an indication that with the current working practices the construction sector in Kuwait is exhibiting, it showed signs of a low to moderate level of LCC. From an operational level, the sector does not fully possess a sturdy "continuous improvement" mentality with their daily working procedures and lacks quality measures that focuses on adding value through the value chain and to simultaneously decrease any wastage in time or resources. From an organizational level, the sector is lagging in being well structured and resilient with its teams. Sites and workplaces are kept in order inconsistently rather than as a standard operating procedure. From the managerial level, the sector's interest is not predominantly focused on long-term goals and is quite satisfied with their status quo, contrary to what LC is based upon according to Diekmann et al. (2004).

Correspondingly, this low to moderate level of LCC indicates that the sector is showing fair signs of acceptance and readiness to Lean Construction application and implementation. Hence, the sector will show medium to low levels of resistance if LC was to be applied more often within and between the sector's role players. This is similar to Tezel and Nielsen's (2013) investigation of Turkey, and Sweis et al. (2016) of Jordan. It is also contrary to Al-Najem et al.'s (2013) study of the manufacturing industry in Kuwait where the Lean readiness levels according to the authors were not found to be promising. Table 9 demonstrates LCC score of the whole dataset from the respondents, in addition to its descriptive statistics.

Table 9. Descriptive Statistics of the Complete Dataset by LCC

Construct	Total N	Sum Score	Mean	Median	Mode
Lean Construction Conformance	55	4896	68.48%	68.46%	46.92%

The main principle of Lean Construction, namely, Continuous Improvement/Built-in-Quality, scored the highest at 70.62% mean value. This indicates that the sector is leaning towards alternative methods of construction by prioritizing quality control measures and teaching every member to have full responsibility in making sure the product/project is up to standard. A finding that is contrary to Sweis et al. (2016) study, where this principle's score was the lowest. In the second rank, main principle Eliminate Waste scored 68.91% mean value. Overall, this is an indication that waste elimination techniques are only somewhat applied and the working hours between groups are not optimized to their highest efficiency. At the third place, main principle Workplace Organization/Standardization scored 68.27% mean value. Similarly, this reflects a moderate application of LC practices in this construct. Organization methods such as the 5S are foreign to some degree and the use of visual management techniques is not obvious in the workplace.

Ranked fourth, the main principle Customer Focus has also indicated a low level of conformance to Lean Construction. At 67.27% mean value, the sector is not dominantly focused on defining the value to the customer. In general, plans and designs are prepared with the intention of delivering them with the fixed requirement with little thorough considerations regarding what is best for the customers' needs. The lowest scoring main principle of the population is Culture/People at 65.33% mean value. This is similar to the study conducted by Mukabana et al. (2015) in Kenya. Staff's appreciation and opinions are not taken into consideration when work is being planned or undergoing and are rarely presented with skill improvement opportunities during their time in the company. Table 10 reflects each main principle's LCC score, in addition to their descriptive statistics.

As seen in Table 4, the highest sub-principle is Work Plan structuring-1. Its score (78.18% mean value) indicates that tasks are planned with moderate consideration to movability and the availability of resources at the job site. Double handling is minimized to a certain degree but not necessarily intentional. Sub-principle Staff Training scored the lowest of all 26 sub-principles at 60.00% mean value. This indicates that companies do not offer many opportunities to train their working staff, and little effort can be seen in trying to elevate their own people's skills and capabilities across all levels of the organization.

Table 10. Descriptive Statistics of Complete Dataset by LCC Main Principles

Main Principle	Total N	Sum Score	Mean	Median	Mode
Customer Focus	55	740	67.27%	70.00%	70.00%
Culture/People	55	539	65.33%	66.67%	66.67%
Workplace Organization/Standardization	55	751	68.27%	70.00%	100.00%
Eliminate Waste	55	1895	68.91%	68.00%	84.00%
Continuous Improvement/Built-In-Quality	55	971	70.62%	72.00%	68.00%[a]

The researcher has also performed a comparison of mean LCC scores for two sets of data. The mean LCC scores for the respondents who reported to have knowledge about LC against the mean LCC score for the respondents who reported to have no knowledge about LC. The comparison was carried out with an independent-sample *t*-test after compensating the prerequisite assumptions about the datasets. The result from the test indicated that there was no statistically significant difference of LCC scores between the two groups. This means that the degree of knowledge about Lean principles had no effect to the degree of conformity to its behavioral practices with Kuwait's industry members.

Limitations

This study did not account for the effects of the corona virus (COVID-19) pandemic on the industry. It is also worth highlighting that the research findings' creditability is subject to the integrity of the participants and their opinions, along with the information provided from the other resources.

The survey was distributed online to several respondents in Kuwait using a non-probability sampling technique – the snowball sampling technique, hence, some bias can be expected from the results obtained (Saunders et al. 2019). This is apparent from the demographics of the sample, where 38 respondents (69.09%) have working experience of 15 years or less and 17 respondents (30.91%) have working experience of more than 15 years. Moreover, Diekman's model was published in the early 2000's, this imposes limitations in later emerging concepts in LC, for example Integrated Project Delivery (Ghassemi and Becerik-Gerber 2011), concepts that can be integrated into future questionnaires to provide a more contemporary investigation about LCC.

Conclusion

The researcher concluded that the sampled respondents demonstrate a low to moderate level of conformity to LCC as mentioned earlier. In descending order of LCC, the five main principles reflected the following:

- Continuous Improvement/Built-in-Quality: The sector is prioritizing producing good quality works across the organization to meet customers' expectations.
- Eliminate Waste: Waste eliminating techniques are moderately applied, and there is still more room for improvement in increasing operations' efficiency.
- Workplace Organization/Standardization: Visual indicators and the application of visual management and organization methods are partially considered and applied in a limited manner.
- Customer Focus: The industry is strict in delivering the work to fixed requirements, rather than presenting the customer with what the ideal options according to their needs can be.
- Culture/People: Showing that companies are not paying a lot of attention to properly developing their working staff, and it indicates that top management is always in control of decisions concerning the work, leaving small room for front line positions in the company to contribute or give their opinions.

The overall mean value indicates that the sector is indeed ready and shows good potential to start implementing LC more thoroughly and in a wider range along the value

chain. This illation would mean that the sector will show medium to low levels of resistance to this reformation of the construction project management approach.

The Kuwaiti construction sector, specifically consultancy firms, can utilize this paper's findings to further develop and enhance the local contractors with their construction practices. The local sector can review each practice and compare the findings of this study to find out which areas of operations, organization or management they can improve to guarantee that their operations and efforts in running the sector are highly productive, competitive, up to standards and most importantly meets the customer's requirements. They need to pay more attention to practices concerning Culture, Value Definition, Site Organization, Task Scheduling, Work Plan Structuring and Staff Training, as they are the lowest in scores in LCC. Moreover, local consultants can start finding ways and methods through case studies on how to overcome these concerns.

The paper has also highlighted that LC's implications are of much value to both the customers and the agents (Al-Adwani and Fleming, 2019; Ansah et al. 2016; AlSehaimi et al. 2014). This should also enable members of the construction sector to be more interested in investigating and applying LC methods of management. Companies who are looking to transition to be Lean can use the study as an introduction about the subject, and transitioning companies from non-lean to Lean can use this assessment tool to measure their conformity levels and whether they are on track or not (Diekmann et al., 2004).

Academically, it is recommended for future researchers who wish to duplicate this study to follow a sampling frame that would allow an equal opportunity for the companies operating in the construction sector to be investigated. They can use focus groups to reflect more accurate answers from the respondents. Researchers can also perform the same assessment after some time to track the progression of LC implementation within the sector. It is also recommended to utilize Diekmann's et al. (2004) in its entirety to guarantee the internal consistency and reliability of the assessment tool is not affected. Future research can also be directed into investigating these areas of concerns and how the local sector can overcome them through case studies that utilizes local companies and organizations as subjects of studies before, during or after Lean implementation and/or introduction.

References

Abdelhamid, T. S., and Copeland, K. (2022). "Lean Construction Journal Editors' Note: 2022 Issue". *Lean Construction Journal 2022*, 1-4.

Adams, Kathrynn Ann, and Lawrence, Eva K. (2019). *Research Methods, Statistics, and Applications*. 2nd ed. Thousand Oaks, California: Sage Publications, Inc.

Aghayev, H., Garza-Reyes, J.A., Nadeem, S.P., Kumar, A., Kumar, V., Rocha-Lona, L., and Gonzalez-Aleu, F. (2020). "Lean Readiness Level of the Azerbaijan Construction Industry." *Proceedings of the 10th Conference on Industrial Engineering and Operations Management*, 1-12.

Al-Adwani, M. and Fleming, A. (2019). "Improving the Construction Industry in the State of Kuwait." *Proceedings of the 14th International Postgraduate Research Conference 2019: Contemporary and Future Directions in the Built Environment*, 202-212.

Al-Adwani, M., Mollasalehi, S., and Fleming, A. (2018). "A Study of Root Causes of Delays in the Public-Sector Construction Projects in Kuwait." *Presented at the International Conference on Construction Futures (ICCF)*, University of Wolverhampton, UK.

Al-Aomar, Raid (2012). "Analysis of lean construction practices at Abu Dhabi construction industry." *Lean Construction Journal*, 105-121.

Alazemi, W. (2013). "Total Quality Management within the Construction Industry of Kuwait: The Role of Total Quality Management and Its Usage." *PhD, Loughborough University.*

Albalkhy, W. and Sweis, R. (2020). "Barriers to Adopting Lean Construction in the Construction Industry: A Literature Review." *International Journal of Lean Six Sigma,* 12(2), 210-236.

Albalkhy, W. and Sweis, R.J. (2019). "Assessing Lean Construction Conformance Amongst the Second-Grade Jordanian Construction Contractors." *International Journal of Construction Management,* 22, 900-912.

AL-Najem, M., Dhakal, H., Labib, A., and Bennett, N. (2013). "Lean Readiness Level Within Kuwaiti Manufacturing Industries." *International Journal of Lean Six Sigma,* 4(3), 280-320.

AlSehaimi, O.A., Fazenda, P.T., and Koskela, L. (2014). "Improving Construction Management Practice with the Last Planner System: A Case Study." *Engineering, Construction and Architectural Management,* 21(1), 51-64.

Andersen, B., Belay, A. M., and Seim, E. A. (2012). "Lean construction practices and its effects: A case study at St. olav's integrated hospital, Norway." *Lean Construction Journal*, 122-149.

Ansah, R.H., Sorooshian, S., and Mustafa, S.B. (2016). "Lean Construction: An Effective Approach for Project Management." *ARPN Journal of Engineering and Applied Sciences*, 11(3), 1607-1612.

Aureliano, F.D.S., Costa, A.Ap.F., Júnior, I.F., and Rodrigues, R.A. (2019). "Application of Lean Manufacturing in Construction Management." *Procedia Manufacturing,* 38, 241-247.

Ballard, G. (2000). "The Last Planner System of Production Control." *PhD, The University of Birmingham.*

Ballard, G. (2008). "The Lean Project Delivery System: An Update." *Lean Construction Journal,* 1-19.

Ballard, G. and Howell, G. (1998). "What Kind of Production is Construction." *Proceedings of the 6th International Group for Lean Construction Annual Conference,* 13-15.

Bluman, Allan G. (2014). *Elementary Statistics: A Step by Step Approach.* 9th ed. New York: McGraw-Hill Education.

Clegg, Stewart, Martin Kornberger, and Tyrone Pitsis (2016). *Managing and Organizations: An Introduction to Theory and Practice.* 4th ed. Los Angeles: Sage.

Diekmann, James E., Mark Krewedl, Joshua Balonick, Travis Stewart, and Spencer Won. (2004). "Application of lean manufacturing principles to construction." Boulder, CO, Construction Industry Institute 191.

DuBrin, Andrew J. (2019). *Fundamentals of Organizational Behavior*. 6th ed. Academic Media Solutions.

Enshassi, A., Elaish, R.A., and Arain, F. (2018). "Barriers of Lean Tools Implementation to Eliminate Construction Waste." *International Journal of Construction Project Management,* 10(2), 123-136.

Fernandez-Solis, J.L., Porwal, V., Lavy, S., Shafaat, A., Rybkowski, Z.K., Son, K., and Lagoo, N. (2013). "Survey of Motivations, Benefits, and Implementation Challenges of Last Planner System Users." *Journal of Construction Engineering and Management,* 139(4), 354-360.

Forbes, Liz, and Shahrukh Ahmed (2011). *Modern Construction.* Boca Raton, FL: CRC Press.

Galang, N. and Galang, E. (2017). "Computer Aided Tool in Science for Kindergarten Pupils." *Computer Science and Engineering*, 7(2), 45-51.

Gao, Shang, and S.P. Low. (2014). *Lean Construction Management: The Toyota Way*. Singapore: Springer Singapore.

Ghassemi, Reza, and Burcin Becerik-Gerber (2011). "Transitioning to integrated project delivery: Potential barriers and lessons learned." *Lean construction journal*, 32-52

GSSCPD (General Secretariat of the Supreme Council for Planning and Development) (2020). H.H. the Amir's Vision. Available at: https://www.scpd.gov.kw/hhVision.aspx (Accessed 9th November 2020).

GSSCPD (General Secretariat of the Supreme Council for Planning and Development) (2021). Kuwait Vision 2035: Progress Report of 2019/2020 Fourth Quarter. Available at: https://www.scpd.gov.kw/Default10.aspx?cate=3 (Accessed 14th May 2021).

Howell, G.A. and Koskela, L. (2000). "Reforming Project Management: The Role of Lean Construction." *Proceedings of the 8th Annual Conference of the International Group for Lean Construction*, 17-19.

Hussin, J.M., Rahman, I.A., and Memon, A.H. (2013). "The Way Forward in Sustainable Construction: Issues and Challenges." *International Journal of Advances in Applied Sciences*, 2(1), 15-24.

Ivancevich, John M., Robert Konopaske, and Michael T. Matteson (2014). *Organizational Behavior and Management*. 10th ed. New York: McGraw-Hill Education.

Ive, G., and Gruneberg, S. (2000). The Economics of the Modern Construction Sector. Springer.

Johansen, E., and Walter, L. (2007). "Lean construction: Prospects for the German construction industry." *Lean Construction Journal*, 3(1), 19-32.

Kavuma, A., Ock, J., and Jang, H. (2019). "Factors Influencing Time and Cost Overruns on Freeform Construction Projects." *KSCE Journal of Civil Engineering*, 23(4), 1442-1450.

Koskela, L. (1992). *Application of the New Production Philosophy to Construction*. Technical Report 72. Center for Integrated Facility Engineering. Department of Civil Engineering. Stanford University.

Koskela, L. (2000). "An Exploration Towards a Production Theory and Its Application to Construction." *PhD, VTT Technical Research Centre of Finland*.

Krieg, Edward J. (2014). *Statistics and Data Analysis for Social Science*. Harlow, Essex: Pearson Education.

Malvik, Tobias O., Torp, Olav, and Johansen, Agnar (2024). "Awareness, Understanding, and Use of Lean Construction in the Norwegian Construction Industry." Lean Construction Journal, 29-58.

McClave, James T., P. George Benson, and Terry Sincich (2018). *Statistics for Business and Economics*. Harlow: Pearson.

Mishra, P., Pandey, C.M., Singh, U., Gupta, A., Sahu, C., and Keshri, A. (2019). "Descriptive Statistics and Normality Tests for Statistical Data." *Annals of Cardiac Anaesthesia*, 22(1), 67-72.

MOFA (Ministry of Foreign Affairs) (2021). Kuwait Vision 2035 "New Kuwait". Available at: https://www.mofa.gov.kw/en/kuwait-state/kuwait-vision-2035/ (Accessed 13th May 2021).

Mossman, A. (2009) "There really is another way, if only he could stop … for a moment and think of it"—Why isn't the UK construction industry going lean with gusto?." Lean Construction Journal, 24-36.

Mossman, A. (2018) "What Is Lean Construction: Another Look." *Proceedings of the 26th Annual Conference of the International Group for Lean Construction*. Chennai, India, 18-20 Jul 2018, 1240-1250

Mukabana, W., Kiplimo, A., and Alkizim, A. (2015). "Assessing Lean Construction Conformance Among Building Contractors in Nairobi, Kenya." *International Journal of Arts and Entrepreneurship*, 4(11), 60-70.

Nesensohn, C., Bryde, D., and Pasquire, C. (2016). "A Measurement Model For Lean Construction Maturity." Lean Construction Journal, 01-09.

Nowotarski, P., Pasławski, J., and Matyja, J. (2016). "Improving Construction Processes Using Lean Management Methodologies – Cost Case Study." *Procedia Engineering*, 161, 1037-1042.

Ozorhon, B., Abbott, C., and Aouad, G. (2014). "Integration and Leadership as Enablers of Innovation in Construction: Case Study." *Journal of Management in Engineering*, 30(2), 256-263.

Robbins, Stephen P., and Timothy A. Judge (2016). *Organizational Behavior*. 17th ed. Upper Saddle River, NJ: Pearson.

Sarhan, J., Olanipekun, A., and Xia, B. (2016). "Critical Success Factors for the Implementation of Lean Construction in the Saudi Arabian Construction Industry." *Proceedings of the 2016 International Conference on Sustainable Built Environment: Actions for the Built Environment of Post-Carbon Era*, 338-341.

Sarhan, S. and Fox, A. (2013). "Barriers to Implementing Lean Construction in the UK Construction Industry." *The Built and Human Environment Review*, 6.

Saunders, Mark, Philip Lewis, and Adrian Thornhill (2019). *Research Methods for Business Students*. 8th ed. New York: Pearson.

Senaratne, S., and Wijesiri, D. (2008). "Lean Construction as a Strategic Option: Testing its Suitability and Acceptability in Sri Lanka." Lean Construction Journal, 34-48.

Shah, R.K. (2016). "An Exploration of Causes for Delay and Cost Overruns in Construction Projects: Case Study of Australia, Malaysia and Ghana." *Journal of Advanced College of Engineering and Management,* 2(1), 41-55.

Soliman, E. (2017). "Communication Problems Causing Governmental Projects Delay: Kuwait Case Study." *International Journal of Construction Project Management,* 9(1), 1-18.

Sweis, G.J., Hiyassat, M., and Al-Hroub, F.F. (2016). "Assessing Lean Conformance by First-Grade Contractors in the Jordanian Construction Industry." *Construction Innovation,* 16(4), 446-459.

Tezel, A. and Nielsen, Y. (2013). "Lean Construction Conformance Among Construction Contractors in Turkey." *Journal of Management in Engineering,* 29(3), 236-250.

Tommelein, I.D. and Weissenberger, M. (1999). "More Just-in-Time: Location of Buffers in Structural Steel Supply and Construction Processes." *Proceedings of the 7th Annual Conference of International Group of Lean Construction,* 109-120.

Ward, S.A. (2015). "Critical Success Factors for Lean Construction." *PhD, The University of Dundee*.

Warid, O., and Hamani, K. (2023). "Lean Construction in the UAE: Implementation of Last Planner System®." Lean Construction Journal, 1-20.

Watfa, Mohamed and Sawalha, Murad (2021). "Critical Success Factors for Lean Construction: An Empirical Study in the UAE." *Lean Construction Journal*, 1-17.

Womack, James P., and Daniel T. Jones (2003). *Lean Thinking: Banish Waste and Create Wealth in Your Corporation*. New York: Free Press.

Appendix 1: Design of the LCC survey

Lean Construction Conformity in Kuwait

(Page 1 - Instructions)
The answers you provide are important and of high value. The data from the survey will aid the researcher to evaluate and measure the Lean Construction conformance levels in the Kuwaiti construction sector. No personal information will be needed or recorded.

(Page 2 - Multiple Choice Questions)
In this part, please choose one answer from the provided options.

(Page 3 - Rating Scale Questions)
The last part requires you to read two statements and then rate which side describes your current situation or practiced behavior. You can choose between 0 (Not applicable), 1, 2, 3, 4 or 5 as an answer.
0 = Not applicable or Rate between (1 - 2 - 3 - 4 - 5)

Click next to proceed to the first part.

Next

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General Information

Are you currently an active professional in the construction sector of Kuwait? *

- ◯ Yes
- ◯ No

How many years of experience do you have? *

- ◯ 0 to 5
- ◯ 5 to 10
- ◯ 10 to 15
- ◯ 15 to 20
- ◯ 20 to 25
- ◯ 25 to 30
- ◯ 30 to 35
- ◯ 35 to 40
- ◯ 40 to 45

What is your educational level? *

- ◯ Lower than Highschool Degree
- ◯ Highschool Degree
- ◯ Diploma Degree
- ◯ Bachelor's Degree
- ◯ Masters Degree
- ◯ Doctoral Degree
- ◯ Higher than Doctoral Degree

What is your current work position? *

- ◯ Projects Director
- ◯ Project Manager
- ◯ Construction Manager
- ◯ Department Manager
- ◯ Project Engineer (Planning, Estimation or Contract)
- ◯ Site Engineer (Civil, Electrical, Mechanical, Environemental, Chemical, Sales or Industrial)
- ◯ General Manager
- ◯ Accountant
- ◯ Human Resource Manager
- ◯ Legal Personnel
- ◯ Site Supervisor
- ◯ Other: _____

Please choose the managerial level that fits your current work position *

- ◯ Lower Level Management
- ◯ Middle Level Management
- ◯ Upper Level Management

Which field of construction are you currently involved in? Choose an answer with highest match *

- ◯ Residential or Commercial Building Works
- ◯ Infrastructure and Utilities Works
- ◯ Mechanical Works
- ◯ Electrical Works
- ◯ Oil and Gas Works
- ◯ Interior and Refurbishment Works
- ◯ Other: _____

Which sector are you currently involved in? *

- ◯ Private Sector
- ◯ Public Sector
- ◯ Both Private and Public Sectors

Do you have any knowledge about Lean Construction or its tools, methods and techniques? *

- ◯ Yes
- ◯ No

Do you consider your self as someone who practices any Lean Construction tools, methods and techniques at your current job? *

- ◯ Yes
- ◯ No

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Behavioral Practices

In this section, please choose one answer from the given options.
(0) = Not Applicable. Rate between (1 - 2 - 3 - 4 - 5) which statement describes your practice.

Value Definition and The Customer (0 = Not applicable or Rate between (1) to (5) *

	0	1	2	3	4	5	
Project objectives are only defined and discussed individually by each project participant and by each department seperatly	○	○	○	○	○	○	Project objectives are defined and discussed with all project participants and departments as a whole. Value to the customer is part of the discussion

Organizational Resilience (0 = Not applicable or Rate between (1) to (5) *

	0	1	2	3	4	5	
Project participants and departments usually work in silos and have weak adaptive skills in replanning and reorganizing when dealing with change orders, making them difficult to overcome	○	○	○	○	○	○	Project participants and departments work together as teams and have strong adaptive skills in replanning and reorganizing when dealing with change orders, making them easy to overcome

Staff Resilience (0 = Not applicable or Rate between (1) to (5) *

	0	1	2	3	4	5	
Each participant can deal with one task or one area of expertise only	○	○	○	○	○	○	Participants have the ability to deal with multiple tasks at several areas of expertise

Value Engineering (0 = Not applicable or Rate between (1) to (5) *

	0	1	2	3	4	5	
The project is completed according to plan	○	○	○	○	○	○	Project participants offer ways to reduce costs without affecting the quality

Staff Training (0 = Not applicable or Rate between (1) to (5) *

	0	1	2	3	4	5	
Project participants are skilled enough to do their job. When required, training courses are done at their personal time only	○	○	○	○	○	○	Training courses are offered to develop more skills in people. When required, training courses are done during working hours

Staff Appreciation and Collaboration (0 = Not applicable or Rate between (1) to (5) *

	0	1	2	3	4	5	
Opinions are usually rejected and not heard by higher management. Continous improvement mentality is neglicted	○	○	○	○	○	○	Every opinion is welcomed in the company. Continous improvement mentality is apparent

Management Proactivity (0 = Not applicable or Rate between (1) to (5) *

	0	1	2	3	4	5	
Management is happy with current company performance	○	○	○	○	○	○	Management continously seeks improvements to increase company performance

Site Organization (0 = Not applicable or Rate between (1) to (5) *

	0	1	2	3	4	5	
Job sites and storage areas are not placed in an organized fashion and locations	○	○	○	○	○	○	Job sites and storage area are placed in an organized fashion and locations, using the 5S method (Sort, Straighten, Sweep, Standardize, Systematize)

Rework Prevention Techniques (0 = Not applicable or Rate between (1) to (5) *

	0	1	2	3	4	5	
Work inspections are rare and reworks are common. There is no mark ups (coloring marks, visual aids) to help with the tasks	○	○	○	○	○	○	Work inspections are always present and reworks are rare. Mark ups (coloring marks, visual aids) are at site to help with the tasks

Visual Management (0 = Not applicable or Rate between (1) to (5) *

	0	1	2	3	4	5	
Project documents (area plan, time schedules, HSE Plans, shop drawing, methods of statements, etc.) are not posted on visible locations for everyone to see in an easy access location	○	○	○	○	○	○	Project documents (area plan, time schedules, HSE Plans, shop drawings, methods of statements, etc.) are posted on visible locations for everyone to see in an easy access location and are up-to-date

Moveability & Availability (0 = Not applicable or Rate between (1) to (5) *

	0	1	2	3	4	5	
Offices and laydown areas are located far from working site, difficult to access and identify	○	○	○	○	○	○	Offices and laydown areas are planned and located in a logistical way for easy access and identification to working site

Work Plan Structuring 1 (0 = Not applicable or Rate between (1) to (5) *

	0	1	2	3	4	5	
Tasks are planned without consinderation of the availablity and moveability of labors, materials and equipments needed for the job	○	○	○	○	○	○	Tasks are planned in consinderation of the availablity and moveability of labor, material and equipment needed for the job

Work Plan Structuring 2 (0 = Not applicable or Rate between (1) to (5) *

	0	1	2	3	4	5	
Working crews perform their tasks in an interupted way between jobs, creating idle hours without working	○	○	○	○	○	○	Working crews perform their tasks in constant motion between jobs without idle hours

Work Plan Structuring 3 (0 = Not applicable or Rate between (1) to (5) *

	0	1	2	3	4	5	
Teams/crews are not prepared with needed materials and instructions before the task starts. This makes it difficult and slow for them to change over with teams/crews who are before them	○	○	○	○	○	○	Teams/crews are always ready with needed materials and instructions before the task starts. This makes it easy and quick for them to change over with teams/crews who are before them

Work Plan Structuring 4 (0 = Not applicable or Rate between (1) to (5) *

	0	1	2	3	4	5	
Materials are bought in bulk without a plan, to avoid shortage in the future. Extra materials are usualy sent back to supplier or thrown into the trash	○	○	○	○	○	○	Materials are bought in precise amounts as needed. There is a defined plan to deal with (if found) extra unused materials

Work Plan Structuring 5 (0 = Not applicable or Rate between (1) to (5) *

	0	1	2	3	4	5	
Equipments are maintained only when needed or broken down	○	○	○	○	○	○	Equipments are maintained periodicaly during after work hours

Tasks Scheduling 1 (0 = Not applicable or Rate between (1) to (5) *

	0	1	2	3	4	5	
Required material are delivered and stored for sometime before use	○	○	○	○	○	○	Required material are delivered directly on time before use without the need to store them

Tasks Scheduling 2 (0 = Not applicable or Rate between (1) to (5) *

	0	1	2	3	4	5	
Tasks and activities start as soon as possible without following the schedule and are usualy behind scheduled delivery	○	○	○	○	○	○	Tasks and activities start as soon as the schedule allows it and are finished as per planned and agreed scheduled delivery

Tasks Scheduling 3 (0 = Not applicable or Rate between (1) to (5) *

	0	1	2	3	4	5	
Sequenced tasks and activites are not completed in a continous flow due to lack of planning (for example: materials required is not ready or the previous task is not complete)	○	○	○	○	○	○	Chained tasks and activites are completed in a continous flow without waiting times. Every task owner is ready to work before the task starts

Work & Quality Assurance 1 (0 = Not applicable or Rate between (1) to (5) *

	0	1	2	3	4	5	
There is a lack of using standard materials and desgins. Methods such as pre-fabrication or pre-assembly are rarely used	○	○	○	○	○	○	It is always encouraged to use standard materials and desgins. Pre-fabrication or pre-assembly methods are constantly suggested as alternative solutions

Work & Quality Assurance 2 (0 = Not applicable or Rate between (1) to (5) *

	0	1	2	3	4	5	
Designs and working methods are made without significance to constructability. On site personnel are not consulted during the designing phase	○	○	○	○	○	○	Designs and working methods are made with constructability in mind, and are checked by every responsible participant

Organizational Development (0 = Not applicable or Rate between (1) to (5) *

	0	1	2	3	4	5	
There is no planned process in dealing with problems at the worksite. lessons learned (feedback sessions) are rarely conducted or documented	○	○	○	○	○	○	There is a planned process in dealing with problems at the worksite. Resulting in lessons learned (feedback sessions) documentation after every task

Quality Measurement 1 (0 = Not applicable or Rate between (1) to (5) *

	0	1	2	3	4	5	
Progress reports of unfinished jobs (work in progress) are not checked or monitored	○	○	○	○	○	○	Progress reports of unfinished jobs (work in progress) are checked on regular basis

Quality Measurement 2 (0 = Not applicable or Rate between (1) to (5) *

	0	1	2	3	4	5	
Quality standards are never looked after. Project participants do not react or report defects when found	○	○	○	○	○	○	Quality standards are always looked after. Every project participant feels responsible towards quality production

Quality Measurement 3 (0 = Not applicable or Rate between (1) to (5) *

	0	1	2	3	4	5	
Progress is not compared with the planned and not discussed with the involved team	○	○	○	○	○	○	Progress is always compared with the planned and discussed with the involved team

Reaction to Defects (0 = Not applicable or Rate between (1) to (5) *

	0	1	2	3	4	5	
There is no specific procedure or plan if a defect is found during task/activity	○	○	○	○	○	○	There is a specific procedure or plan if a defect is found during task/activity that allows the responsible team to stop the work until the defect is resolved in an element

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