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THE EFFECT OF LEAN METHOD ON THE CONSTRUCTION INDUSTRY ACCORDING TO MAJOR CONSTRUCTION COMPANIES IN IRAN

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ABSTRACT

The construction industry is considered to be among the main pillars of any nation's growth, development and progress, all over the world which is also important to modify the norms of society and contributes to the economy of each country. Iran as a developing country faces many problems in the construction industry which can be mainly categorized into three areas of lack of quality, low productivity, and high levels of wastes. This paper aims to fill the existing gap by using the lean in the country's construction industry and examining the effects of implementation of lean culture in the construction industry of Iran. Survey research was selected as the research method for this study, using a questionnaire followed by complementary interviews. The present study has been conducted to identify the weaknesses of the construction industry. Finally, it was concluded by the obtained results that the lean culture is efficient in the country's construction industry, however, it was found that minor changes are needed to implement this method. It was also found that Iranian construction companies require some modifications in order to adopt the lean method.

Keywords: *Lean culture, Construction industry, Productivity, Waste, Quality*

INTRODUCTION

In the past, many researchers have studied the construction industry's problems, especially in terms of productivity and waste (Oyenuga and Naoum, 2015). The wastes in this industry have caused many environmental problems, such as global warming (Aadal and Harirchian, 2013). It has also been determined that the industry is struggling to increase its quality (Li et al., 2017). So much research has been conducted in this field, but mainly carried out in developed countries, which is practically not applicable to many countries.

Lean construction culture is a new philosophy that leads to construction production management (Issa, 2013). Types of wastes that are considered in the Toyota way and Lean culture include waste of production, time, transportation, and the production of defective products (Issa, 2013). On the other hand, there is a lot of pressure in the global market on companies active in the construction industry to maintain competition, which leads to implementing various programs of continuous improvement, customer requirements, and offering more opportunities (Jensen and Larsen, 2018).

Focus on Lean Construction

On top of the existing concepts and methods of management in construction related companies, it is necessary to integrate a method called Lean thinking with the life cycle of a project in order to organize the building projects and to advance towards the goals of the

organization (Ansah and Sorooshian, 2016). Lean management (LM) is a powerful managerial approach, generally recognized as a general improvement in the operational performance of a company (Liker, 2004). Lean construction is also defined as a production management strategy for achieving a significant continuous improvement and acts in the performance of the entire business of a company by eliminating all wastes since the time of production as well as other sources that do not add any value to the product (Womack and Roos, 1990).

For example, Shahriyar Sorooshian and Richard, proposed to precisely recognize and prioritize the practical tools of lean culture for better implementation, in a study which was remarkably different from previous investigations. The biggest difference was that they provided a new method considering delay control and based on AHP.

For example, Li, S., Wu, X., Zhou et al. conducted research on the effects of the Lean culture in the construction industry in China, the country with a large construction industry that has supported the implementation of Lean construction technologies in recent years. However, the current situation and the extent of Lean construction in China have not been yet well studied. The objectives of this study include: assessment of the extent of Lean construction in China; and investigating the factors affecting the Lean construction in construction companies of China. In this paper, two construction companies of various sizes, organizational structures, scope of work and cultures are evaluated based on the information collected through interviews and questionnaires. Finally, it was found that different companies have different operational levels of Lean construction; and the main parameters determining the implementation of Lean culture in China include knowledge of lean construction, organizational structure and organizational culture and market factors.

For example, Marhani & Jaapar A. et al. investigated the accessibility of the Lean culture tools and its implications on the quality of the construction product through survey research using a questionnaire. The questionnaire of this study was sent to contractors registered in the Malaysian G7 Group. Based on the findings, most Lean tools implemented in the Malaysian construction industry consist of group work, regular daily meetings and S5. Also, utilization of Lean culture tools can have a positive impact on the quality of construction projects.

For example, Ko, C.-H., & Kuo, J.-D. have stated that the main costs of the construction projects are related to the materials and wages. Therefore, cost engineering is a key factor affecting the success of the project. The purpose of this study is to implement Lean production techniques in cost engineering design (process engineering) in order to reduce wastes, in particular by developing a Lean construction model. In this paper, molding operation was carried out through the Kanban system to reduce the number of molds and achieve continuous construction. A case study was also investigated to confirm the application of the proposed model. Finally, it was found that the proposed Lean model could effectively reduce the wastes in the construction process and increase the value of the operation, so a new approach is provided to improve cost engineering.

For instance, Fernández-Solís, J. L., & Gadhok, N. evaluated the effects of the Lean culture and the six sigma method in the construction industry. A structured literature research (SLR) was conducted to identify and compare Lean culture and Six Sigma case studies and the related findings and results. At the end of the study, it led to a matrix that identifies the barriers, benefits, and opportunities of using Six Sigma methods and Lean cultures.



Research objectives:

What the present study seeks to achieve is to identify the causes of the gap and lack of progress in construction industry, such as quality, waste, and productivity, and to implement Lean culture behavioral method in order to integrate and unify the construction industry from the inside. In fact, research objectives can be summarize as follows:

- The effects of Lean culture in the construction industry
- studying the feasibility of implementing Lean culture in the construction industry
- understanding the factors affecting the construction industry such as: quality, waste and productivity
- examining the conformity of the existing behavioral method in Iran with the Lean culture
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Hypothesis:

- Lean culture behavioral method plays an important role in the construction industry.
- With the implementation of the Lean culture in the construction industry of Iran, quality and productivity improve and wastes are reduced.

RESEARCH METHODOLOGY

According to Krippendorff's (2008) studies, values are part of our "core beliefs" that affect the whole research process including research problems, guide patterns, theoretical framework, data collection techniques, analysis strategies, etc. It should be noted that values play a great role in the study of Lean culture, knowing the fact that the primary goal of the Lean culture is to maximize the value for the customer.

To this aim, this paper consists of three fundamental steps, first step is the literature review. After expressing the problem and its scope and dimensions in this section, the Lean culture, the existing and implemented theories, the implications and approaches of implementation of this method will be explained. One of the goals of this section is to identify the basic foundations of the Lean thinking method.

In The second step, which initiates by gathering information through mixed methods from large construction companies quantitatively and qualitatively by questionnaires and interviews.

The third step is validation of the research, which presents the findings of the fieldwork as well as the proposed Lean culture in the construction industry. It should also be noted that survey research method was used in this study.

FINDINGS

The data collected in four stages were statistically analyzed by SPSS version 17.0. In the first stage, the degree of implementation, and the importance of understanding each feature of the various principals of Lean culture, were examined. Significance tests have been performed afterwards in order to evaluate the differences between the implimentation levels of the Lean culture and the importance of each one. The findings have been divided into two sections of the questionnaire and interviews and analyzed.



First Part - Questionnaire:

It is worth noting that in light of the fact that the Lean culture and Toyota way are too close and knowing that the Lean culture is actually emanated from the Toyota method, the fourteen Toyota management principles and the Lean culture are combined and made the basis of research method. As a result, each of the principles of the Lean culture is briefly referred to as (P) principal. 400 copies of this questionnaire were sent to potential respondents in 2018. At the end of January 2019, 93 completed copies were returned, representing a valid response rate of 24%.

Second Part - Interview:

Key participants from 16 companies were interviewed using a specific framework for questions, within four months. These interviews were conducted with the aim of obtaining a rich source of information to determine whether the principles of the Lean culture in Iran have an executive strategy or not. The interviewees were selected from the questionnaire part participants who responded to the questions enthusiastically. The interviews lasted about one and a half hours, and were generally carried out at the site offices and major offices of the companies.

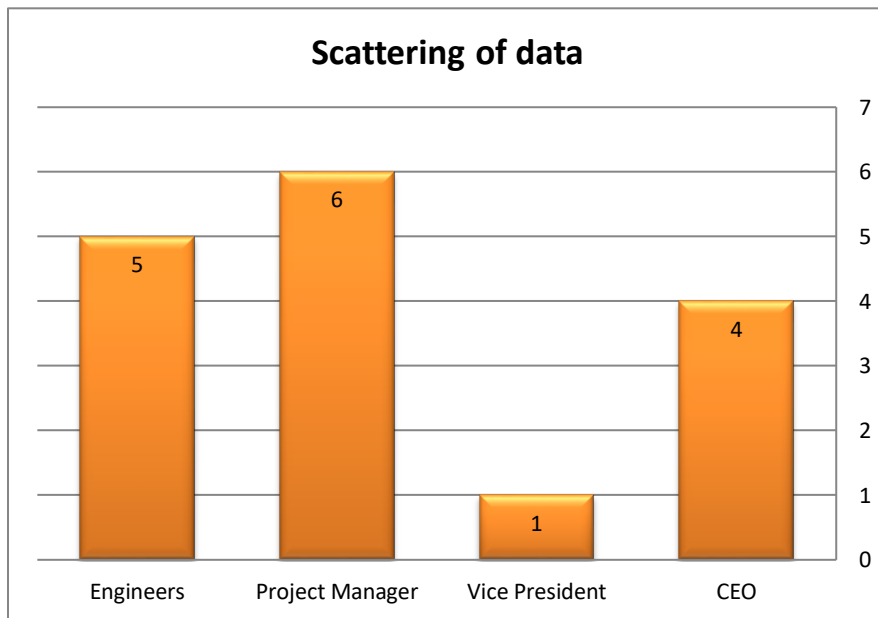


Figure 1: Data distribution of participants

Interviewees were asked that how each of the basic principles of Lean culture can be implemented in the Iranian construction industry on the basis of their recent or past experiences.

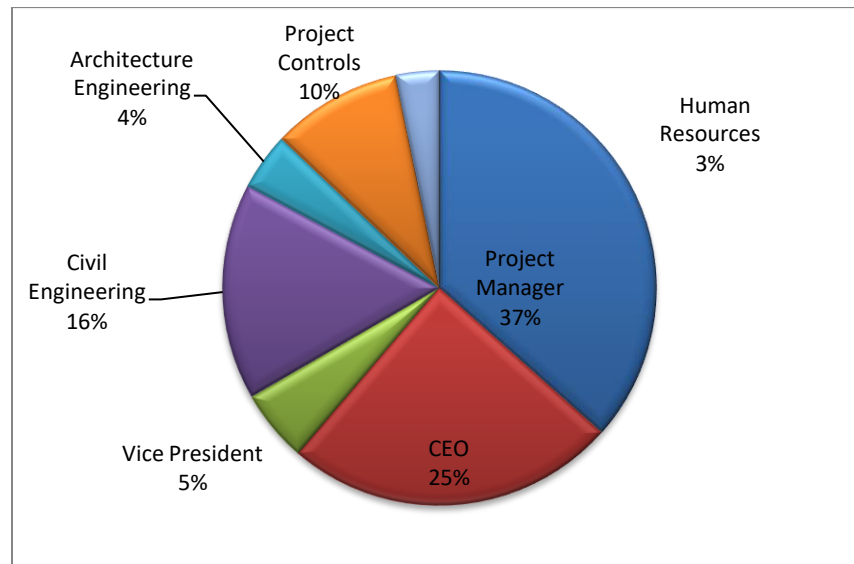


Figure 2: Data distribution of participants(in term of percentage)

Reliability:

In the literature, the word "reliability" refers to reliance on something, for example, on self-tools, or the service of people (Krippendorff, K. , 2008). Reliability is the degree of consistency between two independent measurements of one indicator. This consistency is usually expressed as a correlation coefficient between those two measurements. In fact, reliability of the community size can ensure data stability for inaccessible phenomena.



Table 1: Reliability of Lean tools(in term of Cronbach's alpha)

Lean way Principle	Abundance	Cronbach's alpha
P1	9	0.882
P2	6	0.841
P3	5	0.793
P4	5	0.791
P5	7	0.878
P6	5	0.859
P7	6	0.874
P8	4	0.905
P9	7	0.895
P10	7	0.92
P11	9	0.918
P12	5	0.801
P13	6	0.87
P14	8	0.99

RESULTS

It can be concluded that the "Lean" culture requires the full acceptance of its principles by the companies. It seems that interviewees have some information about Lean processes, but they use decentralized methods instead of creating a comprehensive philosophy. Another

remarkable point is that only a small percentage of interviewees mentioned the role of individuals in the implementation of Lean approaches.

In the end, the obtained results are as follows:

In general, the majority of the features of Lean culture are accepted in the manufacturing and construction industries. Statistically speaking, 15 out of 91 features of the Lean culture, were not executive ($p > 0.05$ or $p > 0.01$).

Training for the first principle of Lean culture was far more observed than other principles in terms of execution. Most of these methods got over 4 points, titled as "averagely executed".

Respondent companies were aware of the importance of Lean and Toyota approaches, but they were not yet fully prepared and interested for implementing them. It should also be noted that all research objectives were obtained in this study and finally all four hypotheses of the study were confirmed.

Future research

This paper has investigated the generality of the Lean culture. Therefore, it is recommended that each of the 14 principles be studied separately.

Making a comparison between Lean culture and Toyota way and combining these principles can help to enhance the understanding of Lean principles.

Further research is also needed in other sectors of the construction industry, such as infrastructures and conventional construction projects.

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