APPLYING LEAN CONSTRUCTION CONCEPTS TO CONSTRUCTION INDUSTRY IN SUDAN

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مُسْـتَخْـلَـص

التشييد الرشيق في ابسط صورة يعني ازالة الهدر من كل جانب من اي عملية للحصول على انتاجية امثل، استخدام افضل للموارد و بيئة عمل افضل. الاه داف الرئيسية لهذه الدراسة هي قياس مدى معرفة المهندسين العاملين في صناعة التشييد في السودان عن التشييد الرشيق، و لمعرفة العوامل التي تؤثر س لباً على سريان عملية التشييد في السودان. بعد تفسير النتائج انتهت الدراسة الى العديد من النتائج منها ان غالبية المهندسين العاملين في صناعة التشييد في السودان ليس لديهم اي معرفة بالتشييد الرشيق، و العامل الرئيس المؤثر على سريان العمل في مشروعات التشييد في السودان هو التاخير في تمويل المشا ريع و في توريد المواد . انتهت الدراسة لعدد من التوصيات من اهمها : بذل خطوات تجاه تحسين سريان العمل في مشروعات التشييد في السودان من خل ال الدراسة المتعمقة للعوامل التي تؤثر سلباً على سريان عملية التشييد للتغلب على مسببات توقف العمل، كذلك الاستعانة بخبراء في التشييد الرشيق لتوجي ه العاملين في مشروعات التشييد بتاسيس معرفة قوية للتطبيق.

ABSTRACT

Lean Construction in its simplest form means elimination of wastes from every aspect of the work process to get more optimum productivity, better usage of resources and better work condition. The main objectives of this study are to determine the awareness about Lean Construction within the engineers who work in the construction industry in Sudan, and to identify the factors that negatively affect the workflow of construction projects in Sudan. After results interpretation, the study ended with many results which are: The vast majority of the engineers who work in the construction industry in Sudan have no idea about Lean Construction and the main factors that negatively affect the workflow of construction projects are the delays in financing the projects and in delivery of the materials. The study reached to a number of recommendations, the most important of which are: Making steps toward enhancing workflow of Sudanese construction projects through deep study of the factors that affect the workflow negatively to overcome all stoppages causes and Hiring lean construction experts to play the role of directors to help actors who involved in the project establishing strong awareness to implement.

Keywords: *Lean Construction, Construction Industry, Workflow*

1 Introduction

Construction industry is a significant sector which plays basic role in both developed and developing countries by creating employment, establishing social infrastructures such as hospitals, schools, bridges, highways, water resources, etc., hence contributing to the gross domestic product(GDP) of those countries [20] . Sudan, as a developing country, has gained obvious developments during the previous decades. These developments took place in many fields, of which the construction industry is a significant on[7]. However, the construction industry in Sudan faces many problems and obstacles, such as: shortage of materials, fluctuation of construction materials prices, inaccurate estimation of the time, defects during the process of construction, cost overrun, too much pressure on project stakeholders, etc.[17].To overcome all above challenges, managing construction nowadays requires knowledge of modern management philosophies, techniques and tools. One of the new revolutionary practices which rooted from the industry of car manufacturing is "lean production". Since the early 1990s, lean production has taken the attention of numbers of researches in the field of construction industry, those people who refer to lean production, created the new term "lean construction" [22]. Lean construction became one of the most important trends in the construction industry recently[16], it is a combination of practical development and original research in both design and construction with an adaptation of the concept of lean production principles and practices to the design and construction process[6]. The lean production in construction industry "lean construction" has its movements that led to form an institute, a group and a refereed journal dedicated to lean construction completely, especially via the universities which located in the continent of America and Northern Europe[22].

2 Lean Construction

The construction industry has adopted the lean production philosophy, which has contributed to the manufacturing industry under name "Lean Construction". Lean construction concept has been tried to be created and promoted by some researchers, institutes, governmental reports, some occupational organizations…etc. The most two famous organizations which have been working to develop the lean thinking in construction, are the International Group for Lean Construction(I.G.L.C), and the Lean Construction Institute(L.C.I)[1] [3][22] .

The first research introduced the lean movement in manufacturing to the construction industry in the year 1992 was by Professor Lauri Koskela by presenting of the initial investigations involving lean construction through a technical report developed at Stanford University . He also hosted the first conference of IGLC in Espoo, Finland in 1993. In that conference a group of researchers adopted the name "Lean Construction". Since 1993, the IGLC has been organizing academic conferences annually, hosted by local universities and institutes from different regions around the globe. The LCI in America was founded in 1997, which has been publishing an international refereed journal devoted to lean construction practice journal. This journal includes papers, reports, and book reviews from industry practitioners and academia [22] .

Lean is a term used to describe a high performance and effective method for managing organizations and delivering their main aim in most effective and efficient manner [18]. Thinking of the process as a lean, means high quality machine, no wasted efforts, everything works smoothly, and efficiency at all-time is high[4]. Lean construction defined as:" a way to design production systems to minimize waste of materials, time, and effort in order to generate the maximum possible amount of value"[13]. Lean Construction Institute defined lean construction as: "a production management-based approach to project delivery -- a new way to design and build capital facilities. Lean production management has caused a revolution in manufacturing design, supply and assembly. Applied to construction, Lean changes the way work is done throughout the delivery process. Lean Construction extends from the objectives of a lean production system - maximize value and minimize waste – to specific techniques and applies them in a new project delivery process"[14].

2.1 Application of Lean Construction

The lean construction philosophy views a project as a promise delivered by people working in a network of commitments. Smooth work flow is dependent on having the parties to a project keep promised that they made concerning the project. When waste is weeded out from a process, workflow becomes more predictable, performance increases and projects can be completed more rapidly[15]. Lean construction distinguishes significantly from traditional project management practice; the processes are actively controlled, and metrics are used in planning system performance to assure reliable workflow and predict project outcomes [11]. The benefits from implementing lean construction include increased workflow reliability, reduced project delivery time, improved communication among project participants, improved supply chain integration, fewer daily problems, and improved quality of work[10]. For lean to be successfully implemented, certain concepts must be applied to suit each organizational goal. These include[8]:

- Awareness: Lean awareness and enlightenment campaigns are necessary to sensitize stakeholders within the construction industry of the opportunities and benefits of lean implementation within the industry.
- Training: The first step towards the effective implementation of lean construction process is training involves teaching stakeholders and practitioners of the lean tools and techniques available to them.
- Application: The implementation of lean techniques within organizations requires high level commitment and involvement of top management.

• Policy: The organizational policy typically describes the principles that guide decisions, procedure and it should establish why the organization supports lean principles and tools, and the policy should also show how and what areas should be applied and in what projects. Lean construction practices have developed quite well, and have lived up to their potential in many different countries around the world, bringing in continuous improvement, inclusive culture and improved levels of certainty in projects. The extent of gains can be seen as influenced by many soft aspects, such as the culture of the site and the organization, planning and engineering expertise available, commitment and support from top management and site management[19]. The great example of the benefits of implementing lean construction is the improvements achieved in Nigeria and Brazil (being developing countries) which they achieved improvements in reducing the project duration by 31% and 25% respectively[21].

3 Methodology

The research methodology included how the structure of the framework for this study was conducted. The main methods were descriptive, explanatory and quantitative. Literature reviews have been taken from books, articles, researches, websites, papers as well as printed materials to describe main concepts about Lean construction. The quantitative was done by collecting data by standardized questionnaire which was distributed to the participants' sample, then all outcome data of the survey was analyzed by using the Statistical Package for the Social Sciences (SPSS) software program version 20 with assistance of a qualified statistician. The questionnaire included multiple choice questions which used widely in the questionnaires. The variety in these questions aims first to meet the research objectives, and to collect all the necessary data that can support the discussion, results, and recommendations of the research. The questionnaire was designed in manner that questions could be answered easily by the respondents; so a set of questions were established to elicit the respondents' opinions about the assessment of workflow in their construction sites, and to know their knowledge about lean construction. The questionnaire was designed basically in English language, then it has been translated into Arabic language; for easement as it is the popular language .Some terms were translated into Arabic by providing additional explanations with English term itself; so that can help the respondents to better understand. The questionnaire comprises of three parts that were designed related to the scope and hypotheses of this study as follow:

- Part one: was structured in order to investigate general information and background about the respondents' level of education, specialty, and their experience in the field of construction.
- Part two: it was structured to show the assessment of workflow in construction sites, and to show the degree of negative impaction of some factors on workflow of construction processes in Sudan.
- Part three: it was structured to examine the respondents' awareness about lean construction, and their opinion about the suitability of lean construction to be implemented in construction industry in Sudan.

4 Data Analysis

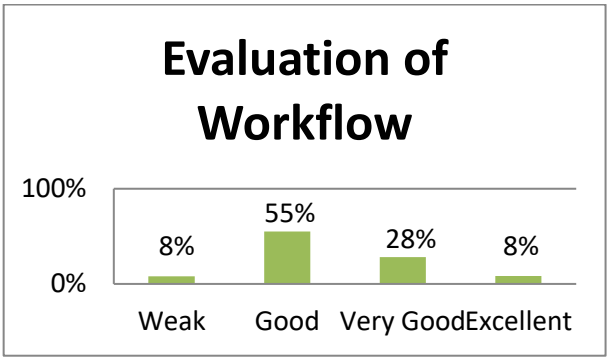

Figure 1: Evaluation of workflow processes in the projects

Figure 1 above present the evaluation of the respondents on the workflow in the construction sites that the respondents work in. Their responds were as follow: 8.3% of the respondents assessed the workflow in their work sites as weak, 55% assessed the workflow as good, 28.3% assessed the workflow as very good and 8.3% assessed the workflow as excellent.

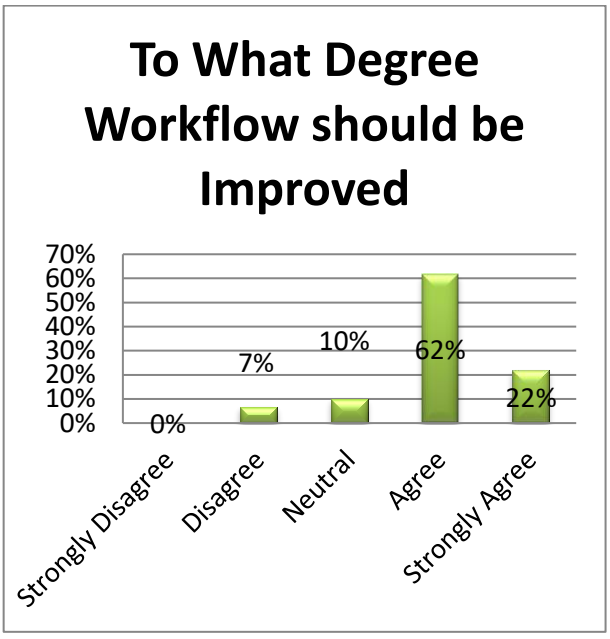

Figure 2: To What Degree the Workflow should be Improved

Figure 2 above present the opinions of the respondents whether they agree that the workflow in their work sites need improvement or not. The results were as follow: 6.7% were disagree, 10% were neutral, 61.7% were agree, and 21.7% were strongly agree.

Table 1: Factors Affect Workflow of Construction Processes

Factors	Disagree	Neutral	Agree
Delays in Financing the Project	13.3%	30%	56.7 %
Change Orders/Specifications during construction	6.7%	55%	38.3 %
Improper Construction Methods	21.7%	51.7%	26.7 %
Mistakes in Design Documents	6.7%	46.7%	46.7 %
Unqualified Labors	8.3%	46.7%	45%
Unorganized Worksite	10%	50%	40%
Delays in Material Delivery	11.7%	35%	53.3 %
Inadequate Details of Drawings	6.7%	50%	43.3 %
Improper Cost Estimation	21.7%	36.7%	41.7 %
Inefficient Communication between project Stakeholders	8.3%	60%	31.7 %
Total	100%	100%	100%

Table 1 above illustrates the degree of negative impact of ten factors on the workflow of construction processes. The choices were disagree, neutral, and agree.

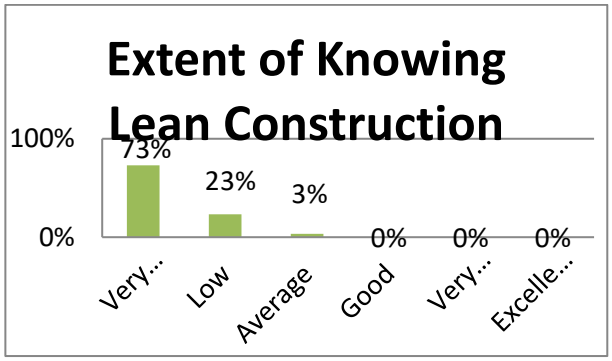

Figure 3: Respondents' Awareness about Lean Construction

The above figure presents the extent of respondents' knowledge about lean construction, the respondents answers were as follow:73.3% are not aware about lean construction, 23.3% have little knowledge about lean construction and 3.3% have good knowledge about lean construction.

Table 2: Challenges May Face the Implementation of Lean Construction in Sudan

	Frequency	Percent%
Difficulties in Understanding the concept of lean construction	21	35
Uncertainty of the Positive Results can be Achieved from the Implementation	9	15
Upper-Level Management will Resist Changing the Current Situation	21	35
The project Stakeholders will Resist to Adopt the Concept of Lean Construction	9	15
Total	**60**	**100**

The above table presents the results of the respondents' opinions about the major challenge will face the implementation of lean construction in Sudan. Their responds were as follow: 35% of the respondents saw that difficulties in understanding the concept of lean construction will be the major obstacle for the implementation, 15% of the respondents suggested that uncertainty of the results can be obtained from the implementation will be the challenge, 35% went with the choice that top-level management will resist to change the situation, and 15% saw that the project stakeholder will resist to adopt the concept.

Table 3: Reason behind Non-application of Lean Construction in Sudan So far

	Frequency	Percent%
Unavailability of researches about lean construction in Sudan	15	25.0
Resistant to Change	10	16.7
Upper-Level Management satisfied with the status que	8	13.3
Ignorance of the Concept	27	45.0
Total	60	100.0

The above table presents the respondents' opinions about the reason behind non-application of lean construction in Sudan so far. 25% of the respondents suggested that the

reason is unavailable researches about lean construction in Sudan, 16.7% of the respondents went with the choice resistant to change, 13.3% of the respondents went with the choice that upper-level management satisfied with status-que, and 45% of the respondents did choose the choice that ignorance of the concept is the reason.

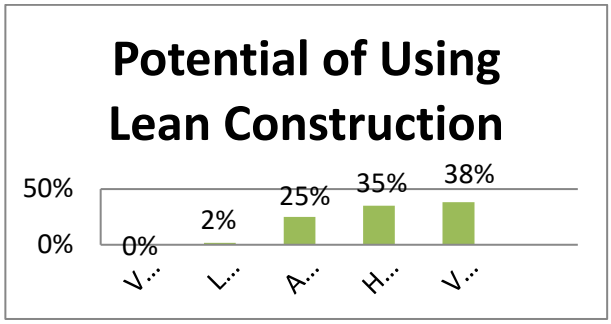

Figure 4: Potential of Using Lean Construction

The above figure presents the responds about the question: To what degree you have potential to work in a construction site uses modern managerial concept as lean construction tools and techniques? The responds were 1.7% of the respondents had low potential, 25% of the respondents had average potential, 35% of the respondents had high potential, and 38.3% of the respondents had very high potential.

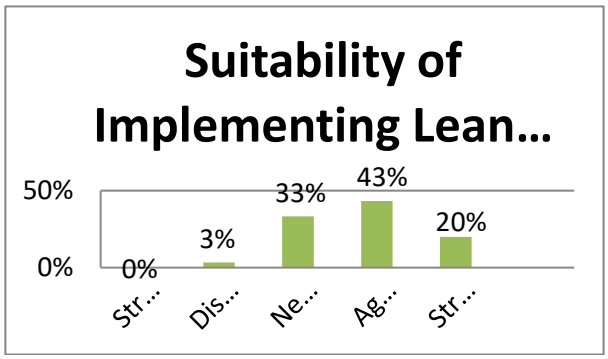

Figure 5: Suitability of Implementing Lean Construction

The above bar chart presents the responds of the question: Do you agree that lean construction suitable to be implemented in Sudan? The responds were 3.3% were disagree, 33.3% were neutral, 43.3% were agree, and 20% were strongly agree.

5 Discussion

From the results of this study the evaluation of workflow in construction projects, 61.7% of the respondents see that the workflow should be improved and that indicates there is necessary to improve the workflow of the construction projects in Sudan. The most factors affect the workflow process in Sudan are the delays both in financing the project and in material delivery. A study was conducted in Ghana by Ayarkwa et al. (2015) concluded that the delays in materials delivery, inefficient use of quality standards, and lack of long-term relationship with suppliers are the factors that affect the workflow in Ghanaian construction sites [5].

The study concluded that more than 73% of the engineers in construction projects in Sudan have no knowledge about lean construction, and about 23% have just little knowledge about lean construction, and that is an indication of the necessity of boosting the engineers' awareness about lean construction. A study was conducted in Egypt found that 55% of the respondents are not aware about lean construction, 45% of the respondents have little aware about it [21]. Another study was conducted by in Palestine found that 65% of the respondents have no knowledge about lean construction [9]. That indicates that lean construction is not known in the most of the nearby countries, not only in Sudan.

The study found that the main two challenges can face the implementation of lean construction are the resistance of upper-level management to change the current situation, and the difficulties in understanding the concept of lean construction. This results are completely agree with a study was conducted in Malaysia found that the main two factors will restrict the implementation of lean construction are the lack of attentiveness and commitment from the top management, and the difficulties in understanding lean construction's concept [2]. Enshassi & Abu Zaiter (2014) found that the challenges of implementing lean construction in Palestine are lack of budget for training, and weakness in the learning environment in construction projects[9]. Another study conducted in India concluded that commitment of top management and site management, as well as the culture and systems of the organization will be main forces for the success of lean construction in India [12].

6 Conclusion

The introduction and implementation of lean principles has had a great effect on the construction industry on the global scale (developing and developed countries) by enhancing workflow and the performance of people in construction which has been mentioned in the literature review of this study. After the results discussion and interpretation were conducted, the study concluded the following:

- The main two factors affect workflow in construction sites are the delays in financing the project and material delivery.
- Workflow in construction sites in Sudan should be improved
- Lean construction concepts are unfamiliar among the engineers who work in Sudan's construction industry.
- The majority of respondents expressed their admiration for working in a lean construction site.
- The reason behind non-application of lean construction in Sudan is the ignorance of lean construction concepts and unavailability of researches in this field.
- The major barrier will face the implementation of lean construction is the resistance of the top management to adopt this concept and making steps toward applying lean construction and change the current situation.

The Study concluded with a number of recommendations in the light of the theoretical part and from the obtained results which are:

- Ensuring that the top management actively adopts the culture of training and developing their staff about new managerial tools and techniques such as lean construction.
- Make steps toward enhancing workflow of Sudanese construction projects through deep study of the factors affect the workflow negatively to overcome all stoppages causes.
- Hiring lean construction experts to play the role of directors to help actors who involved in the project establish strong awareness to implement.
- It is very essential to hold seminars in the universities and institutes, because knowledge of new topics often comes from universities, and other academic organizations.
- It is very essential to encourage the councils of engineers and the associations to hold lectures and training courses to enrich the engineers about lean construction.
- It is important to train the organizations and make sure that everybody thoroughly understands lean construction well to ease the implementation of the concept.

7 Reference

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