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APPLICATION OF LEAN CONCEPTS IN THE CONSTRUCTION INDUSTRY

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Abstract: Sri Lanka is a developing country experiencing a huge construction boom. All construction use various types of resources and waste of resources occur at all construction sites. These wastes include not only material resources but also labour, equipment, time, space, etc. The basic idea of lean is to create more value for the customer with fewer resources. Lean construction projects are easier to manage, safer, complete sooner and cost less and the end product is of better quality. The aim of this study is to understand the level of awareness on lean concepts in the construction industry of Sri Lanka, identify the wastes and classify using lean concept, identify barriers and difficulties that may be encountered in the implementation of lean concepts and propose effective and efficient means of lean construction management techniques to be adopted by the Sri Lankan construction industry.

Keywords: Lean, Construction, Waste minimization

1. Introduction

The simple idea of lean is creating more value for customers with fewer resources. Reducing waste along entire value streams, less capital, and less time, creates processes that need less human effort, less space, to make products and services at far less costs and with much fewer defects, compared with traditional business systems. Companies are able to respond to changing customer desires with a wide variety, high quality, low cost, and with a short period. Also, information management becomes more accurate and much simpler (Gilbert, 2008).

Lean principles were originally derived from the Japanese auto industry, the Toyota Corporation. Lean Construction is a combination of operational research and practical development in design and construction with an adaption of lean manufacturing principles and construction process. Unlike manufacturing, construction is a project based-production process. (Remon, 2013).

In the past several decades, the manufacturing industry changes with some technical and managerial levels. Once being the symbol of industrialization and development, the construction industry has been increasingly criticized for remaining "backward" and being static parallel to the changes in the manufacturing industry. Coupled with various environmental dynamics, these criticisms have been turning into searches for a suitable improvement framework for the construction industry. (Low, 2013)

The construction industry has wasteful practices and struggles to satisfy the parties involved. It is also an important and fundamental industry that its shortcomings create huge baneful effects. The people, who strive for a better construction context, set their eyes on the manufacturing industry. One of the revolutionary practices, rooted from the car manufacturing industry is lean production. Just after the 2nd World War, lean production helped the Japanese car manufacturers to compete against their Western competitors and spread rapidly in other countries. These days most of the companies are trying to apply the lean manufacturing methodologies/tools for their companies. There are many books, papers, societies, technical reports about lean production (Koskela, 1992).

From the early 1990s, lean production techniques have been adopted by the researchers in the construction industry and the name "Lean Construction" originated from "Lean Production". Especially via the

universities located in the American continent and Northern Europe, lean construction is developing and lean practices are diffusing into the construction industry. Lean concepts suggest to construction industry to change their conventional management in to both flow and value management projects (Koskela, 1992). It also attempt to adapt the practical tools/ methodologies of lean production to the construction industry. Unlike other countries the Sri Lankan construction industry is yet to adopt lean construction management techniques. The main focus of this study is on the implementation of lean concepts and to analyse and propose effective and efficient means of lean construction management techniques to Sri Lankan construction industry.

1.1 Research objectives

1. What percentage of leading contractors is aware of lean construction techniques?

2. What extent has lean construction been accepted into practice by the construction industry

3. Identify the wastes sources classified under lean construction industry.

4. Study, analyse and propose effective and efficient means to improve lean construction management techniques to Sri Lankan construction industry.

2.0 Literature review

2.1 Beginning of the Lean Concept

After the end of the Second World War Taiichi Ohno an engineer in the Toyoda Spinning and Weaving Corporation was called to the automotive side of the company. He was asked to improve operational productivity and drive in concepts of Just-In-Time and Jidoka. He was appointed as the machine shop manager of an engine plant and had to experiment many concepts in production in middle 90s. His work and effort was resulted in what is now achieved in the Toyota Production System. There are other people inside the company who contributed to the overall development of the Toyota Company and its production system. The concept of Jidoka was the very first part of Toyota production system and it was created in 1902 by Toyoda founder. After that they were created a number of other tools and new ways, such as seven Wastes and eliminated techniques, kaizen, Andon, 5S, Error proofing, etc. (Meier, 2008).

2.2 Lean manufacturing

The idea behind lean manufacturing is to enhance the value of the customer mean while eliminating the waste. Lean manufacturing lead the company to achieve high performance by generating more value using minimum resources. Waste is a non-value adding activity for a company. By reducing and eliminating waste in the manufacturing process, organizations could focus more on processes that need minimum human participation, minimum floor area and minimize lead times high quality manufacturing with a significant low cost than the traditional manufacturing. (Nilmini Thilakarathna, 2012).

2.3 Applying lean concepts in construction industry

As a result of Lean construction, a new form of production management system came in to construction. Essential features of lean construction include a clear set of objectives for the delivery process, aimed at maximizing performance for the customer at the project level, construction, and the application of project control throughout the life cycle of the project from design to delivery. The lean concept has emerged and has been successfully applied to complex and simple construction projects. In general, lean construction projects are safer, easier to manage, completed on time and cost effective and are of better quality. This research discussed the implementation phases of lean construction showing the waste in construction and how it could be minimized (Remon, 2013)

Projects are not permanent production systems, they are temporary production system. Therefore those systems are planned to complete the product while maximizing value and minimizing waste.

Lean project management differs from traditional project management (Senaratne, n.d.).

3.0 Methodology

The research methodology was used to achieve the objectives of the project. Basically we can identify the following steps.

3.1 Sample selection

The method of the data collection for the project was through a questionnaire survey. The questionnaire was distributed among construction industry professionals working in the building construction industry.

3.2 The survey

Survey questionnaire was divided in to three sections. The first, section was titled "Questions regarding the experience and the about company"

The second section of survey was titled "Questions regarding the waste management of sites" These questions attempted to find out whether the company had proper management system to eliminate the waste and identified whether they use lean principle or any another method.

The final section of this survey titled "Questionnaire regarding lean concept in construction industry". The questions attempted to find barriers to implementing lean concept in construction industry in Sri Lanka, suggestion for implementing Lean concept and get an idea about their knowledge on lean principles.

The questionnaire survey was carried out using three methods. The questionnaire form was distributed among construction industry professionals by hand and via email. Face to face interviews were conducted with selected project managers, site managers and site engineers on a several projects.

3.3Analysis of responses

After the survey responses were received, analytical examination was carried out.

The survey included eight types of wastes. The total outcome of this study was to find out whether the above mention wastes did occur at construction sites and whether there was a conventional procedure in eliminating those wastes. The questionnaire survey was focused on comparing evaluating merits and demerits of comparing conventional and lean construction management concepts.

The survey was also used to analyse for possible barriers and difficulties in implementing Lean concept in construction industry in Sri Lanka.

The questionnaire results were ranked according to Likert scale. The rank results were analysed according to the mean value calculation using equation 3.4.1.

Mean value $= \sum (ni \times xi) / \sum ni$ equ (3.4.1)

xi= Likert scale for item, where

I = 1,2,3,4,5

n = frequency of item

4.0 Results and Discussion

Extracted information from questionnaires and direct interview can be present as follows.

Survey questionnaire was designed in three sections. The first section included questions regarding the experience and background of the respondent and his company. This section helps to get an idea about responder's position in this field.

4.1 Type of the company in responder work

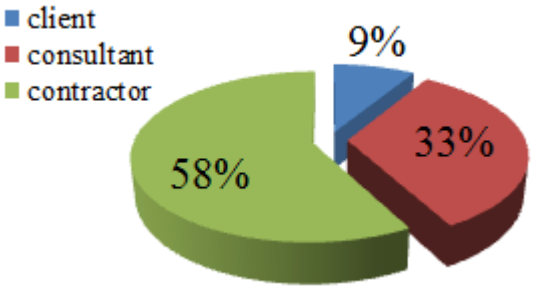

Fig 4.1 Type of the company in responder work

According to above result most of responders work as a contractor. Less number of persons works as a client.

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4.2 Position of the responder

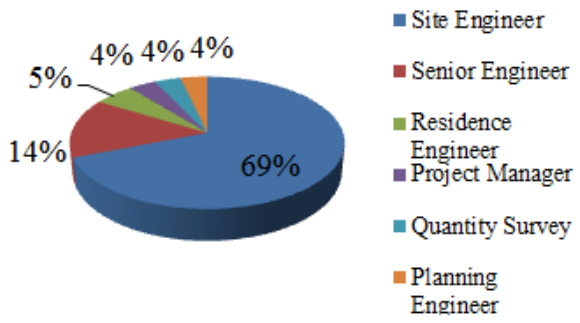

Fig 4.2 Position of the responder

Working experience in construction industry responders experience was most effecting factor when doing this kind of survey. Therefore in this questionnaire form responder's experience was categorized as follow.

1. <5 years 35
2. 5-10 years 17
3. 10-15 years 3
4. >15 years 2

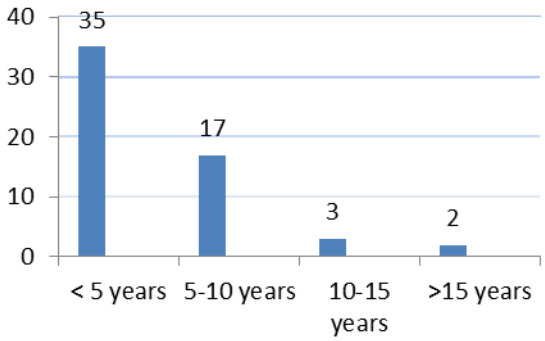

Fig 4.3 Working experience in construction industry

The second section of survey included questions regarding the waste management of sites.

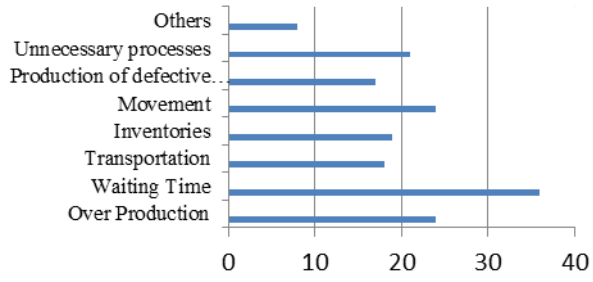

Fig 4.4 Wastes in the construction sites

Table 4.1 Analysis results of the difficulties in implementing of waste minimization

	Mean value	Rank
Lack of promotion of waste minimisation extent	3.877	4
Low financial incentive	3.456	7
Expectations from client	2.964	8
Competitive market	3.714	5
Complicated sub-contraction system	3.56	6
Lack of training awareness	4.316	1
Lack of effective management tools	4.192	3
Change of culture and behaviour	4.246	2

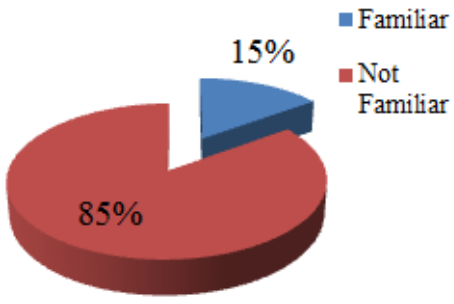

Fig 4.5 Responder's familiarity with the word "lean construction"

Table 4.2 Analysis results of the effective ways to improve the construction waste management plan

	Mean value	Rank
Proper training and education	4.263	1
Employ prefabricated building components	3.281	5
Implementing contracts with sub-contractors	3.649	4
Apply information technology	4.07	3
Top management support and commitment	4.193	2
Appropriate site layout planning	4.263	1
Recycle waste operation on-site	4.07	3

Table 4.3 Difficulties in implementing of Lean concepts in the construction industry Sri Lanka

	Mean value	Rank
Peoples and partner issues	3.596	4
Managerial and organizational issues	3.789	1
Lack of support issues	3.701	2
Cultural and philosophy issues	3.667	3
Government issues	2.982	6
Procurement issues	3.316	5

4.3 Comments and suggestion from the industry

From the google document and face to face interviews (with questionnaire) with some site Engineers, project managers, Residence Engineers, Quantity surveys and Planning Engineers. Implementing of lean construction techniques in the construction industry from

- It's better to introduce new legislation related to lean construction for Sri Lankan construction industry.
- Attitude is the most important factor for in this industry
- Improving waste management process does not result in extra consume extra cost but it will improve the quality of a particular activity which will ultimately help to increase quality and minimize the rework
- Client consultant and Contractor need to work more closely when applying this concept for a project. Basically client needs to pay attention to lean construction from the beginning for example in the preparation of the specifications and other requirements. Consultant need to include the facts of the concepts in their checklists and must monitor regularly, the contractor need to include the facts related to Lean concepts in their methods statements etc.
- Lean concept is already use for some extent in precast fabrication to innovate and implement new trends to the industry.
- Need to arrange a system for removing waste from site as beneficial.
- This is a good concept to be adopted in a third world developing country like Sri Lanka.
- Proper planning prior to ordering of materials and careful handling are also important
- Need awareness programme in advance
- People behavior is the major issue

5.0 Conclusions

- Most people don't know the word "Lean Construction".
- People use another waste minimization technique.

- Identified the extent of difficulties in implementing lean concepts in the construction industry of Sri Lanka.
- There should be a proper mechanism to educate the people about lean construction principles.
- Communicate the benefits of lean construction through seminars & conferences to the construction industry practitioners.
- Government should enact policies which appreciate effort by firms which adopt lean principles.

This should eventually percolate to the lower level of the construction field.

References

[1] Koskela, L., 1992. Lean Production In Construction, finland: s.n.

[2] Low Sui Pheng, T. H. F., 2013. Modern-day lean construction principles. pp. 523 - 541.

[3] Remon Fayek Aziz *, S. M. H., (2013). Applying lean thinking in construction and performance. Alexandria Engineering Journal, p. 679–695.