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Study on Applications of Lean In Constructions

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ABSTRACT

This paper aims to evaluate Lean Thinking applications possibilities concerned with the construction job site flows, by identifying the potential of using lean principles to structure implementations, seeking broader results. From one hand, previous studies indicate that it is feasible to use lean tools and techniques in construction sites. On the other, poor implementations of lean concepts are often observed when tools are implemented in isolation, without a full lean system perspective. In a manufacturing environment, mapping the value stream is an essential step in creating a lean endeavor, generally followed by the implementation of flow and pull tools. The authors argue that using the five lean principles is a step in the right direction also on construction sites, enabling the discussion of Lean Thinking applications from a rather fragmented and isolated view to a strategic point of view. Finally, the authors suggest actions for implementing available lean tools as part of a broader perspective, based on lean principles.

KEYWORD: Lean Thinking, lean construction, construction management, construction site, flow and pull.

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I. INTRODUCTION

Construction can be regarded as a mechanism of generating employment, and offering job opportunities to millions of workers around the world. Therefore it plays an essential role in the socio-economic development of a country. the construction industry is one of the most sensitive activities within any country's economy. Two of the most noticeable factors affecting the construction industry are the internal market variables and the consumers' demand.

Lean thinking is a concept where the focus is to achieve the same kind of performance in areas where it has been applied . As a concept, Lean thinking evolved from the car manufacturing industry in Japan with its roots in the Toyota Production System. It is a production philosophy which seeks for the elimination of waste of all kind in the production process. While Lean thinking was successful in the car manufacturing, its applicability in the construction industry was questionable due to the fundamental differences between mass production and one of a kind type of production. Subsequently, several authors have studied its implementation in the industry and its encouraging results. According to Picchi (2002), the construction industry has been one of the first sectors to discuss Lean thinking in an environment different from where it has been developed.

The Lean movement in the construction industry began in 1992 with the creation of the International Group of Lean Construction (IGLC). Since then, the concept has gained raising popularity with many construction companies trying to implement the philosophy in their current form of project management .Lean philosophy focuses on the entire value stream of a construction project. They argue that one area in this value stream where waste and inefficiency are still apparent is along the supply chain. Studies in the construction industry performed by Bertelsen (1993) suggest that poor supply-chain design regularly increases project cost by ten precent.

OBJECTIVES:

- To study lean wastes & tools.
- To find out lean wastes in construction industry.
- To identify lean tools & techniques to minimise lean wastes.
- To give result & conclusion.

II. LITERATURE SURVEY

B.J.Hick. UK (2007) carried out "reviews of Lean information management:Understanding and eliminating waste."

This paper deals with the development of a new approach for supporting the improvement of information management and the overall information systems infrastructure. In particular, the paper discusses the application of lean thinking to information management; where information management can be considered to involve adding value to information by virtue of how it is organised, visualised and represented; and enabling information (value) to flow to the end-user(customer) through the processes of exchange, sharing and collaboration.

Gao Shang. Singapore (2014) , is carried out reviews of " The Last Planner System in China's construction industry — A SWOT analysis on implementation."

The Last Planner System™ (LPS) is well-documented in the literature, and has sometimes been used to represent lean construction or lean project management. LPS aims to achieve reliable workflow by encouraging foremen to have a sense of ownership of the project programme and to build-in their commitment into it. This study reports on the perceptions of Chinese building professionals of the application of LPS in Chinese construction projects.

Mohammed AlManei UK (2017), Is carrird out review of " Lean implementation frameworks: the challenges for SMEs."

Implementation of lean manufacturing in any type of organizations can bring many benefits, such as reducing waste and improving operating efficiency. However, lean implementation is not a straightforward process. Although a number of frameworks have been presented, still many companies find it difficult to implement lean. Furthermore, most of these roadmaps are for large manufacturing companies, and not for small and medium enterprises.

Sheila Belayutham Malaysia (2016) is carried out reviews of "Faculty of Civil Engineering, Universitiy Teknologi MARA, 40450, Shah Alam, Selangor, Malaysia."

Earthworks operation occupies only a short period of the total project duration but comes with a high cost, mainly due to the use of heavy machineries and skilled operators. Regardless of the short duration, negative effect of the operation on the environment is detrimental, especially from the perspective of site sediment pollution. However, the current body of knowledge lacks improvement strategies that could enable simultaneous enhancement of the production and environmental factors during the operation period.

Usama Hamed Issa Egypt (2013) is carrird out reviews of "Implementation of lean construction techniques for minimizing the risks effect on project construction time."

The construction projects involve various risk factors which have various impacts on time objective that may lead to time-overrun. This study suggests and applies a new technique for minimizing risk factors effect on time using lean construction principles. The lean construction is implemented in this study using the last planner system through execution of an industrial project in Egypt.

III. CASE STUDY

Table Observations made during VSM Studies

In addition, the data collected during the VSMs has been extremely valuble to estimate the general efficiency rate at a construction site. Once all the VSMs had been made the results could be aggregated and a value of the projects efficiency was given. An example of a filled in data protocol is seen in Table 8.2. All activities that were observed during the VSMs have been classified and grouping of operations, namely: Value Adding activities(VA), Non-Value Adding activities (NVA) and Necessary Waste (NW). This data collection process was made for all VSMs and the data from this is for the reader to be found in Appendix H- Value Stream Mapping Data Collection. However, the results of the VSMs are presented in Table 8.4 and the results differ quiet a lot between the different construction processes. The percentage of value adding activities was anywhere between 40% whereas non-value adding activities have been between 48% and necessary waste were found to be between 12%.

No.	Observations	Analysis
1	It was rather common that when a construction worker needed a specific tool it was shed or where the construction worker left it. In that sense the worker had no idea of where the tool might be or who might have taken it. This resulted in a lot of unnecessary walking around at the construction site searching for the tools and starting up conversations with random colleagues which lead to time being wasted on small talk	For some workers there seem to be no willingness to keep track of tools or keep the tool shed tidy. Since this do not goes for all workers it can be assumed to be an individual issue such as lacking a structural mind. However, since it was mainly plumbers who had these problems it could be lack of training or structural thinking within the firm performing the plumbing activities. Nevertheless, looking for tools turned out to be rather time consuming thus costly.
2	It happened from time to time that when a construction worker needed material that was not at hand the worker had to walk relatively long distances to pick it up it was common that the worker had to take this walk to the same place several times during the same day. Turthermore, it happened that material was not where it was suppose to be since it was processed by a colleagues at another location at the site, forcing the worker to start looking for the colleague. All of this resulted in a lot of	We got the impression the planning of the net day's activities was rather uncommon. Often it was planned that something was suppose to be done but not what kind of materials that were needed or how much of it. This point towards the lack of structuring a work day or a problem. That material cannot be found due to other workers processing it on another location show that the communication between workers should be improved. The lack of communication can also explain the problems with

	unnecessary walking at the construction site and sometimes conversations with random colleagues were initiated which lead to time being wasted on small talk.	planning ahead since these often correlate. Nevertheless, the material issue resulted in a lot of time being spent on walking around at the construction site.
3	We observed how construction workers sometimes had to stop performing their activities in order to help out colleagues in looking for material, tools or solving a problem. At other times workers had to wait on colleagues to finish their work first before the worker could carry on with the activity that was under process. It wasin those cases common for the waiting construction worker to take a break and sit down, looking at the colleagues and waiting for them to finish. This resulted in time being spent on nothing at all.	In this case it was obvious to be a planning mistake by the manager who had assigned too many workers for the job. However, it is partly the workers fault as well due to their unwillingness to inform the manager of the over capacity. Some people prefer to find ways to work as little as possible where others have a better work ethic. Another explanation to the scenario could be that specific tools which requires special license were needed for the work task and perhaps only a few people possess these. This could therefore justify the over capacity of human resources.
4	If mistakes had been made in earlier construction processes this was not identified until much later on in the project. This could sabotage a whole working day and lead to a lot more extra processing of material, use of machines and time, Furthermore, sometimes mistakes were tried to be solved with muscle strength (e.g. lifting heavy materials) which increased the risk of injuries.	The underlying factor to this problem might be poor communication between different kinds of construction workers (e.g. the plumber do not talk to the carpenter). Therefore it could be argued that all the actors within a construction project have to be better at team work and help each other. It is also problematic to not have any systematic procedure to make follow ups if quality is deficient. This results in that more mistakes will be made in the future without any possibility to avoid them or find the source of the problem .

Table Analysis of VSM s

The Aggregated Result of the VSMs

If all the VSM studies are summarized an aggregated result will be given. This result is shown in Appendix H – Value Stream Mapping Data Collection and Figure 8.1 shows that roughly 40% of the workers' time at the construction site is spent on value adding activities that need to be optimized while 48% of the time is non-value adding activities which need to be eliminated. There is also necessary waste accounting for 12% which needs to be minimized. The discrepancy in results concerning necessary waste and value-adding and what is necessary.

However, the 33% that is pure waste makes it fair to say that the construction industry is struggling with efficiency problems. There is a great deal that can be done, not only to eliminate the non-value adding activities and minimize the necessary waste but also to optimize the value adding. During the observations it was observed that clever building design has the possibility of greatly affecting the amount of work needed for completion. By taking the problems and difficulties faced by the different construction workers on a daily basis into account when designing a lot of extra work can be avoided.

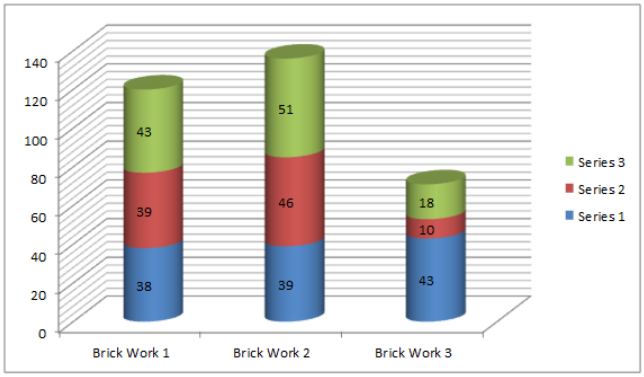


Fig 1.analysis

Validation Case

To validate the lean tool that has just been presented it was tried out on a construction process at a large size construction company. The first four steps of the Lean Construction Tool were carried out after I had followed a construction worker performing a pipe installing process. The findings from this validation case are presented in the following sections.

Situation Analysis

A VSM was conducted and the result is being presented in Table 8.5 A dialogue was held with the construction worker about the different activities to give the we better understanding about the construction process. The data that was collected showed that approximately 40% of the activities were value adding, 48% were non-value adding and 12% were necessary waste. This is being displayed in Figure 1

Starting time 11:16 AM

Activity	Classification	Duration
Talk	NVA	1:10
Searching tape	NVA	2:22
Set Level	VA	1:25
Lifting Material	NW	0:46
Placing Material	VA	2:17
Lifting Brick	NW	3:10
Placing Brick	VA	0:25
Talk	NVA	1:17
To Chek Level	VA	3:19
Talk	NVA	2:03
Filling Mortar	VA	0:45
Walk	NVA	0:54
Lifting brick	NW	0:12
Walk	NVA	0:53
Placing brick	VA	3:10
Talk	NVA	1:15
To Check level	VA	2:40
Rest	NVA	4:55
Filling Mortar	VA	1:10
Walk	NVA	0:56
Lift Brick	NW	0:35
Talk	NVA	1:20
Talk	NVA	1:10
Walk	NVA	0:54
Placing Brick	VA	3:34
Talk	NVA	1:30
Filling mortar	VA	1:40
Walk	NVA	0:54
Lifting brick	NW	1:30
Walk	NVA	0:30
Placing brick	VA	3:10
Check level	VA	2:10
Talk on mobile	NVA	7:30
Walk	NVA	1:35
Lifting brick	NW	0:35
Walk	NVA	0:54
Placing brick	VA	2:35
Warning for mortar	NVA	4:17
Filling mortar	VA	3:10
Talk	NVA	2:50
Walk	NVA	0:57
Lifting Brick	VA	0:12
Walk	NVA	0:53
Catting brick	NW	2:37
Placing brick	VA	4:10
Check Level	VA	3:56
Rest	NVA	12:10
Lifting brick	NW	0:35
Placing brick	VA	3:10
Check Level	VA	4:45
Filling mortar	VA	3:16
Catting brick	NW	2:10
Lifting brick	NW	3:40
Placing brick	VA	4:47
Talk	NVA	0:35
Check Level	VA	4:07
Rest	NVA	0:35
Walk	NVA	0:55
Lift bricks	NW	2:17
Walk	NVA	0:56
Catting bricks	NW	2:30
Placing of bricks	VA	4:15
Leveling of bricks	VA	2:01
Filling mortar	VA	3:38

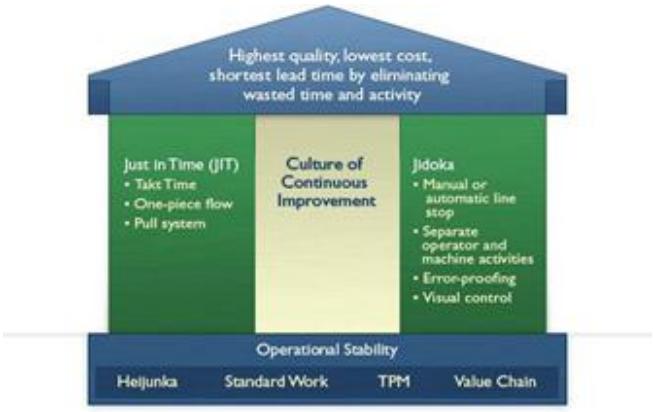
Lunch Break 55:10 Min.

Activity	Classification	Duration
Talk	NVA	1:10
Searching tape	NVA	2:22
Set Level	VA	1:25
Lifting Material	NW	0:46
Placing Material	VA	2:17
Lifting Brick	NW	3:10
Placing Brick	VA	0:25
Talk	NVA	1:17
To Chek Level	VA	3:19

Talk	NVA	2:03
Filling Mortar	VA	0:45
Walk	NVA	0:54
Lifting brick	NW	0:12
Walk	NVA	0:53
Placing brick	VA	3:10
Talk	NVA	1:15
To Check level	VA	2:40
Rest	NVA	4:55
Filling Mortar	VA	1:10
Walk	NVA	0:56
Lift Brick	NW	0:35
Talk	NVA	1:20
Talk	NVA	1:10
Walk	NVA	0:54
Placing Brick	VA	3:34
Talk	NVA	1:30
Filling mortar	VA	1:40
Walk	NVA	0:54
Lifting brick	NW	1:30
Walk	NVA	0:30
Placing brick	VA	3:10
Check level	VA	2:10
Talk on mobile	NVA	7:30
Walk	NVA	1:35
Lifting brick	NW	0:35
Walk	NVA	0:54
Placing brick	VA	2:35
Warning for mortar	NVA	4:17
Filling mortar	VA	3:10
Talk	NVA	2:50
Walk	NVA	0:57
Lifting Brick	VA	0:12
Walk	NVA	0:53
Catting brick	NW	2:37
Placing brick	VA	4:10
Check Level	VA	3:56
Rest	NVA	12:10
Lifting brick	NW	0:35

Placing brick	VA	3:10
Check Level	VA	4:45
Filling mortar	VA	3:16
Catting brick	NW	2:10
Lifting brick	NW	3:40
Placing brick	VA	4:47
Talk	NVA	0:35
Check Level	VA	4:07
Rest	NVA	0:35
Walk	NVA	0:55
Lift bricks	NW	2:17
Walk	NVA	0:56
Catting bricks	NW	2:30
Placing of bricks	VA	4:15
Leveling of bricks	VA	2:01
Filling mortar	VA	3:38
Activity	Classification	Duration
Talk	NVA	1:10
Searching tape	NVA	2:22
Set Level	VA	1:25
Lifting Material	NW	0:46
Placing Material	VA	2:17
Lifting Brick	NW	3:10
Placing Brick	VA	0:25
Talk	NVA	1:17
To Chek Level	VA	3:19
Talk	NVA	2:03
Filling Mortar	VA	0:45
Walk	NVA	0:54
Lifting brick	NW	0:12
Walk	NVA	0:53
Placing brick	VA	3:10
Talk	NVA	1:15
To Check level	VA	2:40
Rest	NVA	4:55
Filling Mortar	VA	1:10
Walk	NVA	0:56
Lift Brick	NW	0:35

Talk	NVA	1:20
Talk	NVA	1:10
Walk	NVA	0:54
Placing Brick	VA	3:34
Talk	NVA	1:30
Filling mortar	VA	1:40
Walk	NVA	0:54
Lifting brick	NW	1:30
Walk	NVA	0:30
Placing brick	VA	3:10



IV. CONCLUSION

We have identified the problems of how the industry works today and pointed to possible solutions by using the lean philosophy and tools along with solutions which is known as lean construction.

We have made research on case studies. This research based on categorization of the types of waste that exist in construction. We also found out the main sources of wastes in construction industry. We have studied lean construction tools by using lean thinking. The last planner system helps to complete the project effectively by forming six weeks lookahead plan, weekly work plan, reverse phase scheduling, Daily planning & measuring the work by using percent plan completion(PPC) So the last planner system should be effectively applied to the construction projects discussed in case studies.

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