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Practicing Lean in Sustainable Construction to Achieve Time Reduction

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ABSTRACT

Implementing new management philosophy in construction became an approach for construction players in achieving optimum output of the process. The practice of eliminating non-value added in the construction process flow is important in creating the elements of time reduction. Therefore, lean is the best approach as a management philosophy to be adopted in construction process flow because of the stabilizing and pulling factors towards construction time reduction. There are few cases being observed and non-value added activities being analysed accordingly to lean approach. From the questionnaire survey, factors of waiting, overproduction and double handling became the most prolongation of the construction time that contributes to delay. The analysis proof that leans has the factor of time reduction and contributes to rapid construction. The construction process flow became stable and the minimum cost being pulled in the construction cycle.

Keywords: lean, rapid construction, construction flow, construction innovation

1. INTRODUCTION

The new approach to construct a building or infrastructure has been to perform faster construction to save money and increase the quality of work. In order to accomplish this, the rapid construction method has to be introduced that allow the policy of get in, get out and stay out. Rapid construction provides a significant opportunity to reduce congestion associated with the construction flow. These methods will lesson project durations while retaining quality. Opportunities for innovative methods of rapid construction are numerous. Normally, the construction player will be thinking of adding additional costs to pull the completion time. However, new management philosophy can be adopted to decrease construction time such as lean construction. This philosophy can be considered as innovation in construction.

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2. RESEARCH OBJECTIVES

This paper promotes the usage of lean in the construction phase to achieve rapid construction. The paper flow by the objective of:

1. Identifying the lack of existing construction process flow.
2. Integrating lean into the construction process flow.
3. Identifying the way to achieve rapid construction using lean.

3. METHODOLOGY

Research methodology as defined in the research method will be carried out in this study. The cost-effective usage of the revenue will only be achieved using the suitable method. Therefore, it is crucial to ensure data and information gathered to be exact and in line with the information and objectives of the study. This research methodology will touch on the aspects of procedure in the implementation of this study to ensure that the findings can be operated more orderly and effectively. This matter aims to ensure all data gathered are based upon valid sources and it is in accordance with objective of the study. The procedure will be starting with understanding the construction problem and the elements of lean principles. There are few cases being observed and non-value adding activities being analysed accordingly to lean approach. Frequency analysis is being used to analyse the perception of respondents from questionnaire survey. Finally, conceptual model been developed as a guideline for construction players in implementing lean to construction process flow.

4. LITERATURE REVIEW

The chronic problems of construction are well known such as low productivity, poor safety, inferior working conditions and insufficient quality (Koskela, 1993) and the phenomenon of the poor performance and conditions in construction had long been witnessed and recorded by academics and practitioners throughout the world regardless in developed countries or in developing countries. Production weaknesses and problem of the industry have to be redefined and reassessed in order to reformat a new strategy and plan for productivity improvement in the construction practices. Egan (1998) in his report of “Rethinking Construction” mention that the UK construction industry at its best and is excellence. Its capability to deliver the most difficult and innovative projects matches that of any other construction industry in the world. So, to get better performance in the construction industries, rapid construction have to be introduced widely as one of the methods in accelerating change of project delivery. Rapid construction is a systematic approach to deliver a one kind project with complexity in construction due to limited time schedule, contract agreement, approved construction method and meets client satisfaction (Yahya & Mohamad,

2011). This definition seems comprehensive and it is covered on the construction physic itself. Osamu (2005) defines rapid construction as a method of construction technology to solve the chronic congestion which decreases construction time. According to Smith (2005), rapid construction involving major step in the development of fusion as a potential large scale sources. Kentucky Transportation Center (2005), in their report of "Innovative Rapid Construction/Reconstruction Methods" briefly describe that rapid construction is a construction project due to limited schedule by using such methodology of construction method and shorter time. Rapid construction is a terminology to enhance the construction process flow and to ensure the successes of project delivery in a chronicle time of contract.

4.1 Inefficiencies in Construction Phase

The construction industry is a tremendous investment in the long period, dynamic production phase with diverse uncertainties. In construction system, it contains different sub-systems which interrelated and influenced each other. Those relationships constitute the whole. The task of a project manager is to organize every phase in scientific order and well schedule. However, the construction system is a dynamic process and influenced by internal and external factors such as weather, budget, government, technique and resources (Ren, 2012). Each of the factors will affect the project. Hence, project works over schedule will occur. In the production process, this is no perfect plan regarding the logistics of a project. The schedule always planned well before the project performing. However, the planning could be performed poorly due to certain unforeseen issues. Considering that, there is a strategy to improve the efficiency and make better use of buffer time in the construction process. Using lean strategy into the construction process flow becomes a success factor to better meet client needs and improve the supply efficiency. In the view of the construction industry, the overall diffusion of the new philosophy seems to be rather limited and its applications incomplete. Quality assurance and TQM have been adopted by a growing number of organisations in construction, first in construction material and component manufacturing and later in design and construction. The new approach, in its JIT oriented form, has been used by component manufacturers such as prefabricate component or Industrialised Building System (IBS). However, it seems that these barriers are of a temporary nature. On the other hand, the slow diffusion is not explained by an inadequacy of the new philosophy with respect to construction.

4.2 New Management Philosophy in Construction

In recent years, applications of new production philosophy in the construction are getting more popular, especially in the developing countries such as the US and Europe. Koskela (1993) identifies the overwhelming dominance of conversion thinking in construction and argues for replacing the conversion model with the flow or conversion model in order to reduce waste. This has inspired Howell, a civil engineer and Research Director, Ballard from Lean Construction Institute of Idaho began to investigate the performance of project planning systems. They later espoused the

concept of "Lean Construction" by seeing a potential for applying the general principles set by Koskela (a researcher with VTT Building Technology in Espoo) into construction (Wright, 2000). According to Lean Construction Institute, lean construction is a production management based approach to project delivery, a new way to design and build capital facilities and it extends from the objectives of a lean production system: maximise value and minimise waste and to specific techniques and applies them in a new project delivery process.

4.3 Lean for Construction Time Reduction

Lean construction as defined by the Lean Construction Institute is "a production management-based project delivery system emphasizing the reliable and speedy delivery of value". The ultimate goal is to carry on the project while maximizing value, minimizing waste and pursuing perfection (LCI, 2002). This definition and adds that lean construction challenges the general concept of trade-off between time, cost and quality employed in traditional construction. Howell (1999) claimed that managing construction under the lean philosophy is different from conventional construction contemporary practice because it:

1. Has a clear set of objectives in the delivery process.
2. Is aimed at maximizing performance for the customer at the project level.
3. Applies production control throughout the life of the project.

According to Pinch (2005), lean construction practices include:

1. Establishing integrated teams of owners, architects, user, builders, specialised contractors, subcontractors and suppliers;
2. Combining project design with process design, simultaneously designing the facility and its production process;
3. Stopping production rather than releasing a faulty assignment or product in the construction process;
4. Decentralizing decision making, empowering project participants and making the process transparent so any team member can see the progress status of the project; and
5. Requiring a simple, direct handoff between tasks in the work stream, with a clear way to request action and receive a response, to eliminate clogs between project phases.

The introduction of new production philosophies in construction requires a measure of performance to suit with the construction time. Construction project come with dateline and variation in project delivery is a fact. Responding to variation is a major aspect of lean. Buffers between operations are an important tool because it allows two activities to proceed independently. Variations in the output from upstream operations do not limit the performance of the downstream operation. The improvement of non-value adding flow activities should primarily be focused on improving reliability if not reducing or eliminate it, whereas conversion activities should be made more

efficient (Alarcon, 1996). Waste eliminating as a main principle of lean will secure the project success. Ohno (1988) identified the following seven wastes in engineering of which the first five refer to the flow of material and the two last ones to work of manpower:

1. Waste of overproduction;
2. Waste of correction;
3. Waste of material movement;
4. Waste of processing;
5. Waste of inventory;
6. Waste of waiting; and
7. Waste of motion.

The majority of the wastes above occur in a construction process flow. Originally, the most important type of waste is considered to be within the process such as stage wise movement of the material through the production system. As evident from the waste list of Ohno, there can be waste also in the utilization of labour and machineries. The waste seems to be three root causes (Koskela, 2000):

1. The structure of production system;
2. The way production is controlled; and
3. The inherent nature of production.

With respect to all three causes, it is possible to eliminate or reduce the amount of waste. However, this principle cannot be used simplistically. Some non-value added activities produce value for internal customers like planning, accounting and accident prevention. Such activities should not be suppressed without considering whether more non value adding activities would result in other parts of the process such defects, have no value to anybody and should be eliminated without any hesitation. Lean construction has a basic improvement on rationale to compress the lead time by eliminating waste. The time refers to the time required for a particular piece of material to traverse the flow. Time reduction forces the decreased of inspection, move and wait times. Experience shows that non value adding activities dominate most processes usually 3 to 20% of steps add value (Ciampa, 1991) and the impact of waste elimination in construction process flow is shown in Figure 1.

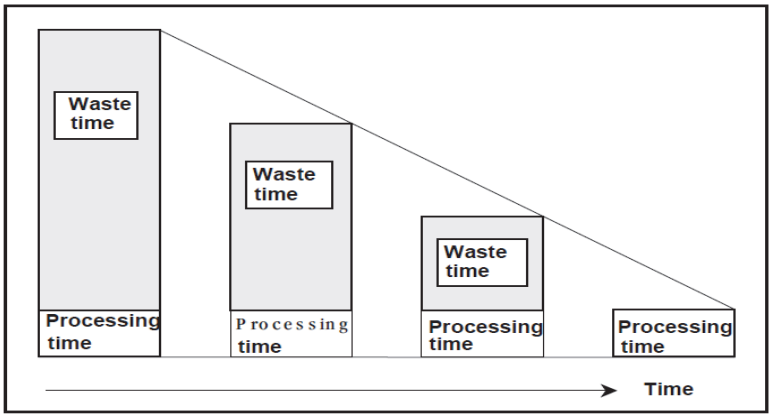

Figure 1: Time reduction through elimination of non-value adding activities and variability reduction (Berliner & Brimson, 1988)

In this regard, the effort is directed towards elimination of rework, inspection, moving and waiting. This process actually will lead to rapid construction. Remarkably, the basic elements of a JIT system can be derived from this. Elimination of rework requires elimination of defects, an objective that can be attained either through classical quality measures or the automation method that used fully inspection through autonomous checking for the abnormalities in a process.

5. ANALYSIS AND DISCUSSION

Process time variability refers to the time required to process a task at one workstation. It consists of natural variability (minor fluctuation due to differences in operators, machines and materials), random outages, setups, operator availability and rework (due to unacceptable quality). Flow variability means the variability of the arrival of jobs to a single workstation. Thus, reduction of variability within flow processes must be considered as an intrinsic goal. The practical approach to decreasing variability then consists of finding and eliminating its root causes. Technology played one of important roles in improving project performance by increasing the speed, accuracy and quantity of output. It seems to be an advantage that can improve the focus of the principles, practices and paradigms in construction process such as:

1. Eliminate human errors;
2. Prevent double handling;
3. Reduce inventories and eliminate the surplus;
4. Create a real time environment;
5. Communication improvement;
6. Allow modular design and construction; and
7. Supply chain improvement.

The classification shown in the table presents some limitations that should be considered according to case studies:

Slow work: This waste of time is related to the efficiency of process, construction equipment and personnel. Then it is difficult to measure it because it is first necessary to know the optimal efficiency that could be reached, which is not always possible;
Rework: Not always is the result of workers ineffectiveness, uncontrolled problems like weather conditions also result in rework although they can be prevented.

The most important causes of wasted time identified were classified as shown in Figure 2.

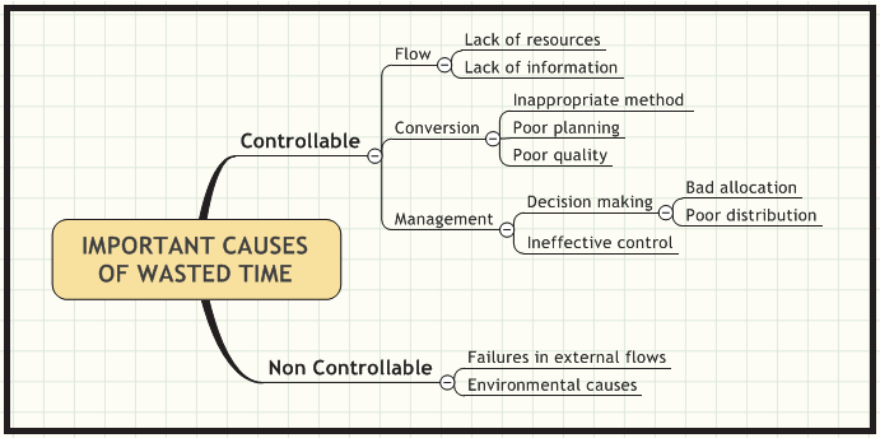

Figure 2: Classification structure of causes of waste time.

It seems to be as a new management concept that related to project management but focus on rapid construction. In the context of rapid construction, the continuous measurement of construction duration is a primary task. This concept offers the flow to measure as in Figure 3.

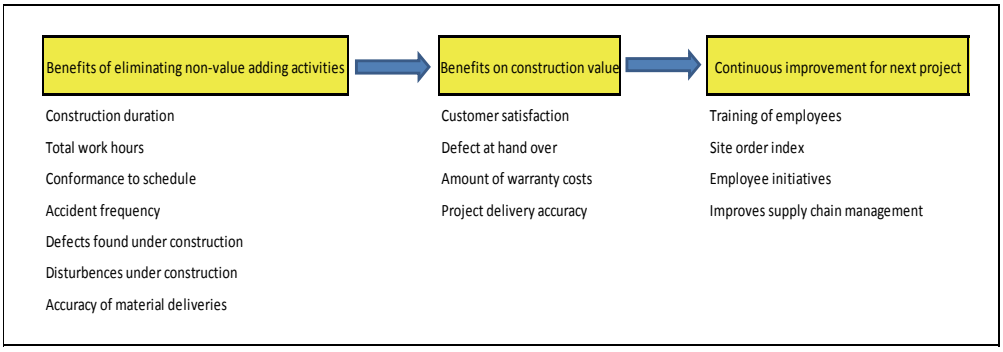

Figure 3: Benefits of lean in construction process flow

The work process is the process flow that shows the entire task and its precedence for the whole project. Normally in the construction industry, critical path method (CPM) will represent the construction flow. Surprisingly CPM not fully understood by some parties in the project team especially the subcontractor. Additional template need in the planning and scheduling technique. Conceptual model for lean will be based from the template as Figure 4.

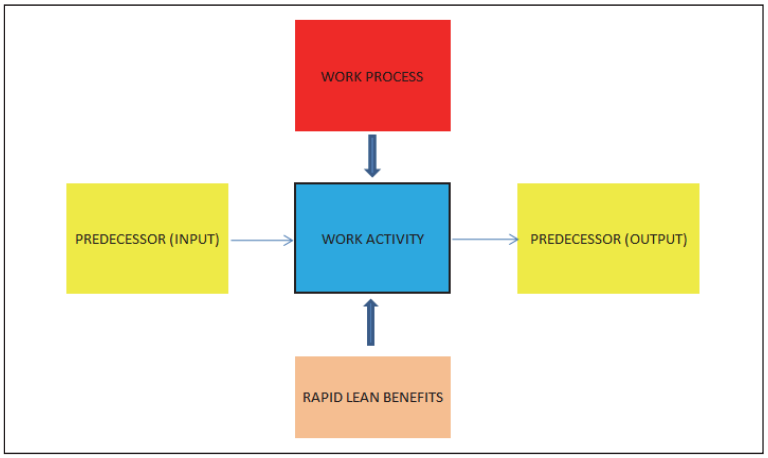

Figure 4: Using lean template as a strategy in process flow improvement

The usage of this template is as guidance for construction players in a brainstorming session or in the preliminary planning in order to establish the work method for the whole construction phase. The predecessor either input or output has determined through the work breakdown structure related to construction activity. On the top section of each activity reserved for work process in order to convert from one activity to another. The process mentions the work or materials needed and also information from one conversion process to another in quick to grasp. Work off or on site can be thought of in term of movement the chain. Stabilizing work in this chain reduces waste and therefore contributes to time reduction. It also requires managing the timing and sequence of the flow of stuff and assuring it meet downstream requirements. On the bottom part, the rapid and lean benefits are to be listed. This model is adequate for assembly operations and the understanding that flows involved in the planning process. Minimizing uncertainty in the flow of decisions and information required in planning is important as minimizing uncertainty in the flow of stuff. Lean represent the visualized of flows associated with planning. It is actually the improvement of existing process flow.

6. CONCLUSION

The traditional lean literature helps to understand the basics of lean concept such as the importance of flow, continuous improvement and waste reduction. It also actually helps grasp the tools of lean that can be used. The literature come together with other literature concerning lean construction and lean in other industries. Historical resistance by the construction industry to accept ideas from manufacturing has limited the acceptance and use of lean construction. The traditional transformation view of construction is contrary to lean principles, which shift the focus from craft production to the overall process (including the design). The goal of lean construction is to make value-added activities flow, which can only be accomplished if lean concepts are included from the very beginning of the design process. Lean construction can be accomplished by considering constructability in the design and construction phase in order to improve flow of the job site. This can only be accomplished by collaborative decision making with the construction players. Design should be selected to enable efficient construction operations and this can only be accomplished through collaboration and constructability validation. Traditional constructability concepts developed in the 1980s still apply to lean construction and can be enhanced through the consideration of how to make the process flow. Standardization of design elements, modularity and pre-assembly are all methods that can improve flow on the construction job site. In addition to consideration of constructability concepts, design teams must be expanded to include contractors, subcontractors and materials suppliers. Communication among all parties will be difficult. However, advances in information technology are making it easier to communicate. Through universal access, all key players can work cooperatively on a design instead of isolated from each other. With increased cooperation and collaboration, it is not difficult to incorporate lean principles into construction practices. The ability to measure before and after when making changes is also an important aspect not only in lean but also in running a business as a whole. To conclude, the implementation of lean construction requires a radical shift in traditional construction methods and gives some space for establishing the new concept of time reduction as construction improvement.

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