PROCESS COMPLEXITY AT THE PRE-CONSTRUCTION PHASE: A LEAN BASED SOLUTION

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SYNOPSIS

The pre-construction phase consists of different stages of work (inception, design, tendering) and participants (client, designer, surveyors), which takes place before construction. The complex nature of work and interactive processes could increase the risk for errors and inefficiencies that may jeopardise the performance of the overall project. Research works have been conducted to improve the pre-construction stage through lean concept and other advanced procurement system. However, the resultants were either too narrow in scope that only caters for a single work stage or too wide, neglecting the detailed processes. The gap in knowledge calls for a more holistic approach in managing the complex pre-construction stage. Therefore, this research aims to establish a conceptual framework that applies lean thinking to reduce process complexity at the pre-construction stage. The objectives conceived in order to achieve the aim are given as follows: 1) To define process complexity; 2) To provide linkage between lean thinking, process complexity and the pre-construction stage; 3) To propose lean based solutions to improve process complexity at the pre-construction stage; 4) To demonstrate the application of the framework in real project. This research is divided into two work phases whereby Phase 1 involves the establishment of framework while Phase 2 involves the demonstration and validation process. In general, the research methods employed consist of literature review and case study on a real project. This study benefits both the academia and industry by providing a new perspective in improving current processes that may lead to positive outcome in performance.

KEYWORDS: Process complexity, pre-construction, lean thinking, Value Stream Map (VSM)

INTRODUCTION

Construction projects have long been plagued with poor performance in terms of time, cost, and quality. Various factors have been identified in the past, ranging from pre-construction to construction based inefficiencies. The pre-construction phase takes place prior to construction, involving different stages of work (inception, design, tendering) and participants (client, consultant, surveyors) (Wood, 2010). Nonetheless, this phase differs from construction as it involves more organisational instead of technical aspect. Pre-construction based problems could originate from any of the work stages and the factors could be traced back to poor communication, insufficient documentation and information, disintegration and lack of construction knowledge (Tzortzopoulos and Fromoso, 1999; Chandrakanthi et al. 2002; Song et al; 2009). The poor performance of the pre-construction stage could lead to negative impacts on the subsequent work stage, as well as the overall project’s performance (Waly and Thabet, 2002; Kolltveit and Gronhaug, 2004). This situation is suggested based on the ‘parades of trades’ concept whereby outcome of the previous works influence progress of
the following works (Tommelein et al. 1999). Therefore, it is essential that inefficiencies at the pre-construction stage being recognised and improved for better performance outcome.

Different works have been done to improve the performance of the pre-construction stage, ranging from advanced procurement system to lean concept. Most advanced procurement system emphasises on collaborative and integrative ideology, neglecting the detailed aspect of processes. Lean concept addresses this gap with the emergence of Lean Project Delivery (LPD) system that allows the perspective of processes involved within a collaborative environment. Nonetheless, the drawback of this system is the need for a major revamp to the entire system and the implementation may well be suited for long term based solution. Lean application in construction also largely focused on the production aspect with little attention given to organisational (administrative waste), where pre-construction stage is most prevalent. Besides that, other pre-construction related lean researches mostly focused on improving a single aspect of the system, such as the design stage (Freire and Alarcon, 2002; Hagstrom and Wollner, 2011). The partial based solutions are not holistic in nature; hence an approach that enables the understanding of processes across the whole stage is required (Abdul-Kadir and Price, 1995).

Processes involved within the pre-construction stage may be described as complex (Wood, 2010). Complexity in construction is well recognised but limited works can be found pertaining to the matter, subsequently creating a huge gap in knowledge for the detailed branch of complexity, which is process complexity. According to Hogan et al. (2012), process complexity is described as the bottom of an iceberg where it is presumed to be the root cause of problems. However, most research works only focused on finding solutions at the tip of the iceberg, where problems (waiting time, defects) are obvious. Therefore, it is essential to improve project complexity because addressing the root cause provides a more sustainable approach in problem solving.

RESEARCH AIM AND OBJECTIVES

Aim of this research is to establish a conceptual framework that applies lean thinking to reduce process complexity at the pre-construction stage. Objectives of this study are as follows: 1) To define process complexity; 2) To provide linkage between lean thinking, process complexity and the pre-construction stage; 3) To propose lean based solutions to improve process complexity at the pre-construction stage; 4) To demonstrate the application of the framework in real project.

RESEARCH METHODS

This research is divided into two major phases of work, Phase 1 and 2. Phase 1 involves the establishment of conceptual framework while Phase 2 involves the demonstration of the proposed framework, subsequently validating the framework. The conceptual framework in Phase 1 is established following criteria proposed by Whetten (1989) by making sure proper reasoning were provided, minimal variables used, focused, complex, original and significant. Phase 2 involves data collection from a real project in order to demonstrate the application of the framework and further validating it. The data collected should portray current processes involved in a real pre-construction stage of a project by mapping it using lean tools such as
Value Stream Map (VSM) and process mapping. The complexity of the processes is analysed and measured using the pre-determined metrics and measurement standard, adapted from two different sources. The first metrics is adapted from Business Process Management (BPM) called Control-Flow Complexity (CFC) by Cardoso (2006). This metric would provide a round figure/value for the complexity of processes. In order to further identify inefficiencies in the modelled current map quantitatively, metrics measurement proposed by US EPA (2009) is utilised, which involves variables such as lead time, process steps, decisions, delays, handoffs and loops.

ANTICIPATED (OR PRELIMINARY) FINDINGS

Process complexity

Generally, complexity can be derived into project and process complexity. Cardoso (2008) has defined process complexity as “the degree to which a process is difficult to analyse, understand or explain. It may be characterised by the number and intricacy of activities interfaces, transitions, conditional and parallel branches, the existence of loops, roles, activity categories, the type of data structure and other process characteristics.” Process complexity of a system could be measured using several different equations proposed by researchers but in this research, the CFC metrics is chosen to be the process complexity measurement tool as it has gone through theoretical and empirical validation with success, as compared to metrics proposed by other researchers (Muketha et al. 2010). The results from the measurement would provide a benchmark on the level of complexity of the system. In addition to that, the relevance of the pre-construction stage as being organisational/administrational requires an in depth metrics to understand the administrative waste in terms of process complexity. US EPA (2009) through their lean government effort has recognised process complexity as one of the metrics to improve their organisation by providing measurement standards. The complementing nature of both metrics allow for in depth understanding of complexity in current processes.

Relationship between lean thinking, process complexity and the pre-construction stage

Lean thinking acts as a one-stop centre in diagnosing the current situation and consequently providing solutions based on lean principles. As discussed, process complexity within the pre-construction stage should be measured and evaluated. In order to do so, lean tools such as VSM, process map and earlier established metrics are used. After benchmarking the current status, future favourable scenario is drawn, adhering to the 11 lean principles proposed by Koskela (1992). Further improvement actions to be taken based on the envisioned future state.

RESEARCH SIGNIFICANCE

This research provides a new perspective in viewing the pre-construction stage as a whole system. The recognition of complexity within the processes enables improvement measures to be taken, subsequently streamlining the processes. In terms of theoretical contribution, this research introduced the perspective of process complexity as a waste, from the administration waste stand point. The established metrics and measurement standards which were sourced
from two different areas allow for rich and comprehensive understanding of the current state. As for the industry, practitioners could use the framework to identify and improve the commonly neglected aspect of process complexity. Positive improvements taken to address the root cause will have positive influence on other aspects of work that eventually increases project’s performance.

REFERENCES


