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ScienceDirect

Procedia Engineering 172 (2017) 969 – 976

Procedia Engineering

www.elsevier.com/locate/procedia

Modern Building Materials, Structures and Techniques, MBMST 2016

Reducing variability of workforce as a tool to improve plan reliability

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Abstract

Variability of flow is recognized as one of the greatest obstacles to production management. Since the work flow and labour flow are two dominators of work performance, it is important to manage them simultaneously. The objective of this paper is to examine if an increased plan reliability could be reached by reducing the variance of a labour flow. Therefore, three different construction labour data sets have been examined by utilizing Monte Carlo Simulation, to analyze the probability to finish simulated projects within a certain time. The research findings revealed that reducing variance of the workforce flow does not necessarily shorten the project length, nevertheless it increases probability to finish the tasks within a critical path duration. Additionally, it was concluded, that reducing the variance of crew allocation can improve the productivity.

Peer-review under responsibility of the organizing committee of MBMST 2016

Keywords: Lean construction; Plan reliability; Flow; Reliability.

1. Introduction

Variability is a common issue in construction management due to the fact that one-of-a-kind-nature-product, fixed in site, and temporary-organizations characteristics, consequently gives rise to changeable and variable conditions [6]. The theory of lean is introduced to the construction industry to maximize the value to the client and to minimize the waste. Lean recognizes that the variability is an obstacle inducing poor performance in production [12]. Recent researches

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Peer-review under responsibility of the organizing committee of MBMST 2016
doi:10.1016/j.proeng.2017.02.115

indicate that using lean techniques can improve the flow reliability, which could lead to better performance [16]. For instance, the most applied lean construction tool, the Last Planner System, is developed to better tackle variability to improve the work flow reliability by shielding upstream, thereupon, contributes to higher percentage of planned activities completed (PPC) [2,3,4,7]. It is crucial to improve the reliability of work flow in the initial phase. To put it simply, reduction of work flow variability can keep the production system under control, just as the Last Planner System revealed, one of the most important rules is sizing a work to match the capabilities of a crew. Nevertheless, the major barriers of implementing the Last Planner System are linked to the soft aspects, such as people and organization process [7], accordingly, sizing the crew to match assigned work should be taken into account as well. On the other hand, the relationship between reliability, variability and performance is complicated to generalize. There is a need for a comprehensive thinking of assignment and the crew abilities.

1.1. Flow in Lean Construction

Lean construction refers to the application of lean technology to construction industry, and first and foremost, is recognizing and properly identifying the flow to target continuity of work, location and time [7]. The first reason is that the flow combines together planning and scheduling. These two dominators of construction management are associated to a task with the seven conditions [11] (else called resource flow). Secondly, it considers the production systematically rather than transformation.

Since information, materials and equipment are the components of the workflow [16], it requires a smooth movement to avoid the circumstance of continuous changes and congestion on site [13,20]. The unstable movement generates waste, impeding workflow, and obstructing the progress. Hence a smooth workflow means the availability of needed resources and components being smoothly transformed and incorporated into the products or structures throughout the production units (PUs). Unlike manufacturing production, construction crew moves from location to location, which is the third type of flow. Location flow is then expressed as the place where all other flows and tasks are intertwined. Necessarily, the labour flow (distinguishing from workflow), should be considered together with the flow management in the lean construction. It involves the allocation of labour resources to tasks, along with the interaction of labours inside PUs and between PUs.

Previous research [16] has suggested that labour resources needs to be more exposed in a lean thinking. On the other hand, the variability in the construction output (at the crew level) is inevitable, yet it should be minimized.

To sum up, it is obvious to notice that the site production (construction production) influences the nature of production flow and temporary organization establishes inter-organizational interfaces between the tasks. Eventually, construction peculiarities significantly affect the flow reliability, thereupon, it can be derived that effective management of flow has critical importance to improve the reliability and the feasibility of the production system.

1.2. Reliability and variability

Reliability means that a system can consistently perform its intended and required mission. It is the result to which degree the designed system can be relied on. Numerically, it is the outcome to show validity of tested results, determined through statistical methods after repeated numbers of trials [16]. This statistical method is generally adopted in the project management field. For instance, Monte Carlo Simulation technique is utilized to calculate the probability (higher probability equals to greater reliability), which is used as a tool for decision making. Variability refers to a range of possible outcomes of a given situation. In general, this cause can be seen from the result of a complex system, which is inherently less reliable than a simple system. As for production itself, there are two types of variability in flows: 1) process time variability, and 2) flow variability [9], and both of them are related to labour flow [2]. The process-time variability refers to the variability of the time that is required to transform inputs into a finished product at one workstation. Flow variability means the variability of the arrival of jobs from inflow to a single workstation.

Variability increases the lead time based on the queueing theory [11] and wastes capacity [9]. On the other hand, Shewhart [18] realized that variability is a fact of industrial existence that could be understood by probability and statistics theory. Therefore, interpreting information as data set, to calculate range, mean, variance and standard deviation, can assess the flow variability.