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COMPUTER SIMULATION-BASED TEMPLATES FOR LEAN IMPLEMENTATION IN SMALL AND MEDIUM CONSTRUCTION ENTERPRISES

Prashanth Kumar Sreram

Indian Institute of Technology Bombay
Department of Civil Engineering
Powai, Maharashtra
Mumbai, 400 076, INDIA

ABSTRACT

A country's economic advancement hinges on the construction sector, but its growth is marred by the global construction industry's chief predicament: tangible and intangible waste. Lean construction employs strategies such as Value Stream Mapping (VSM), yielding crucial time and cost savings. Presently, VSM's execution is limited to static process representation, segregating preparation, and assessment of enhancement alternatives. In the era of construction 4.0, embracing technological and digital shifts is imperative, enhancing performance via simulation. Hence, uniting Lean Construction with Simulation becomes essential, validating lean principles through simulation models and aiding improved project decision-making. Thus, research concentrates on crafting VSM-based discrete event simulation (DES) models tailored for small and medium enterprises in the offsite construction realm. The current focus is offsite construction, while forthcoming research addresses complex activities, refining simulation models as valuable tools for industry practitioners.

1 INTRODUCTION

The construction industry's significant role drives infrastructure development and influences national competitiveness. The industry’s Punctual, budget-adhering project execution is essential, as delays and cost overruns breed inefficiency and waste. In response, lean construction departs from traditional time and cost-centric methods, adopting flow-focused perspectives. Although lean tools such as VSM enhance material flow and waste reduction, their deterministic nature contrasts with uncertainty in construction. Computer simulation offers a dynamic solution, accommodating uncertainties. This study proposes a VSM-based simulation model, illustrating practical lean application through hollow core slab casting.

2 RESEARCH GAP

Value Stream Mapping (VSM) functions as a versatile lean tool, enhancing production by depicting material and information flow classifying processes as non-value adding, necessary but non-value adding, or value adding. While VSM remains static, its synergy with computer simulation results in dynamic value stream maps (Solding and Gullander 2009). The simulation further aligns with lean principles, facilitating modular construction efficiency offsite lean improvements through discrete-event simulation, real-time production analysis, and economic assessment of fabrication practices. Though prior endeavors have coupled simulation and lean (Nikakhtar et al. 2015), the construction sector grapples with barriers like limited knowledge, intricate processes, high costs, and multidisciplinary skill shortages, impeding simulation adoption by small and medium enterprises (AbouRizk, 2010; Solding and Gullander, 2009). Thus, this study strives to develop a VSM-based DES template, facilitating the construction industry's integration of simulation for lean practices.

3 VSM-BASED DES MODEL TEMPLATE FOR HOLLOW CORE SLAB CASTING

The scope of the work is to develop simulation models for use in construction for lean implementation. Considering the uniqueness of construction projects, which makes the use of the models difficult, the models will be user input-based and provide an opportunity for the user to opt for scenarios and check the impact of each scenario so that it helps decision-making. Figure 1 shows the simulation model developed in Anylogic for the hollow core slab (HCS) casting. The simulation window seeks inputs from the user on the possible reduction in non-value addition (NVA) in each HCS activity. Once the inputs are frozen, the simulation will run with the chosen reduction strategies and come up with overall time completion. As small and medium enterprises cannot afford to invest in factory simulation models, so they can use these templates for better decision-making at the operational planning level.

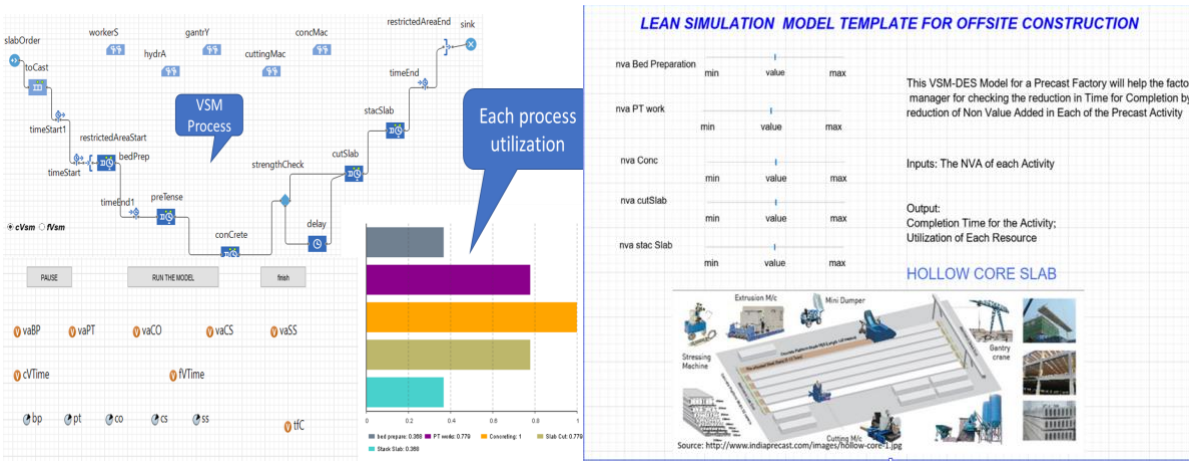

Figure 1: VSM-based DES Model Template for Offsite Construction.

4 FUTURE WORK

This ongoing model is expanding to include cost and environmental considerations for decision-making regarding potential savings from NVA reduction strategies. Enhancements will involve refining model reliability through additional process cycle time data from various factories (automated and manual) and addressing labor shortages, holidays, and risk events to bolster robustness. Incorporating probability distributions and goodness-of-fit statistics to enrich process durations will transform the model into a reusable template for expediting lean implementation in construction. Although factory input shaped the study's scenarios, sensitivity analysis will foster parameter interaction.

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