*Proceedings of the 2023 Winter Simulation Conference*
*C. G. Corlu, S. R. Hunter, H. Lam, B. S. Onggo, J. Shortle, and B. Biller, eds.*

# DEVELOPMENT OF A DISCRETE EVENT SIMULATION BASED FRAMEWORK TO EVALUATE SIX SIGMA IMPLEMENTATION IN THE CONSTRUCTION SECTOR

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## ABSTRACT

Six Sigma is a useful technique adopted in the construction industry to attain supreme quality levels by reducing the variability in the processes. However, rigorous field implementation of a Six Sigma methodology takes time, money, resources, and stakeholder commitment. This study develops a simulation-based framework that can mimic a Six Sigma implementation effort in a construction site using a discrete event simulation technique. Such a framework helps the decision makers to check the benefits of Six Sigma by assessing what-if scenarios for possible system improvement, even before expending the time and resources needed for field implementation of Six Sigma techniques. Therefore, through a combination of discrete event simulation and Six Sigma, the variations in a process at a construction project are eliminated. The results of this study can inspire construction managers to use simulation to understand Six Sigma implementation and improve the process or system to fulfill customer needs.

## 1. INTRODUCTION

The construction industry has always been concerned about defects, as they can increase project costs. Therefore, a construction project must have an adequate quality management system for the identification of defects and overall performance improvement. In general, Six Sigma(SS) is a powerful continuous improvement strategy that uses statistical tools and methodologies to reduce process variability in business processes. Even though SS is a useful technique, SS implementation has a few challenges such as the need to spend time and cost to visualize the potential benefits.

The main objective of this study is to use simulation to quickly gather insights on implementing SS in construction sites and find the best SS strategies for a process/project (Sacks et al. 2014).The major goal of this study is to combine simulation capabilities into an SS method for quick reactions and building project deployment(El-Haik et al. 2006)

## 2. RESEARCH BACKGROUND

While it may seem that integrating SS principles into construction processes and practices is crucial, SS field implementation has several challenges. Selecting the team and sending them for SS belt training before deployment is resource-intensive. Similarly, implementation of SS requires aggressive investment management techniques which enhances the project costs in terms of full-time staff requirements for implementation and rollout. Likewise, an SS rollout also demands a lot of time investment to realize the benefits.

To address the above challenges, this study proposes a simulation-based approach that helps to visualize the SS benefits even before its implementation in the field. In this study, a process-level modeling tool, namely "JaamSim", simulation software that supports discrete-event simulation (Lang et al. 2021) is used to represent a construction process. As a free and open-source discrete event simulation software, it is chosen for its capacity to handle simulations, input/output processing, model building, and the dynamic nature of interactions between objects and system processes that depend on both time and quantity.

## 3. SIMULATION MODEL

This paper developed a discrete-event simulation model for precast concrete duct casting for an underground metro project. Several precast ducts were needed for an underground metro station in the casting yard. Achieving consistency in quality has caused several of these ducts to be rejected at the installation site. The developed simulation model mimicked the duct casting process by detailedly adding all production processes. To replicate statistical distribution interactions, site data was used to generate random variables from probability distributions. Figure 1 below illustrates the developed Six Sigma SIPOC Model. This snapshot shows a typical simulation run where there are 12 good-quality ducts and 29 failed ducts with an assumed construction process flow.

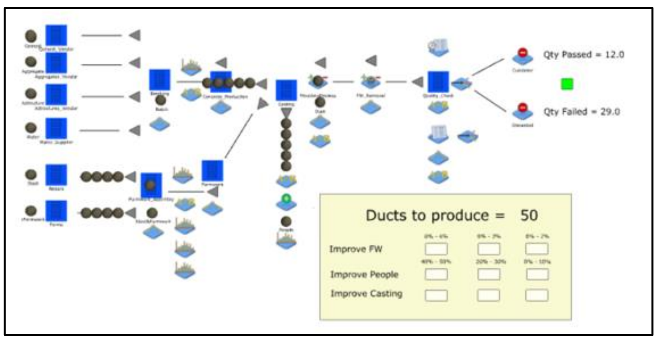


Figure 1: A snapshot of a simulation run.

## 4. VERIFICATION AND VALIDATION

To ensure that the DES model is properly constructed, the model input-output transformations were compared with the corresponding input-output transformations of the real system and the data collected from the site. Such a verification ensured that the simulation model matches the conceptual model, while validation ensured that it accurately represents the system based on case study data.

## 5. CONCLUSIONS AND IMPLICATIONS

This study developed an innovative DES simulation-based approach to demonstrate the benefits of SS implementation at a construction project site. The approach developed through this study presents an opportunity for other industries to understand how beneficial an SS implementation would be even before a rigorous field implementation is attempted.

## REFERENCES

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