Proceedings of the 2019 Winter Simulation Conference
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EXPLORING DES USE IN PRODUCTION SYSTEM DESIGN WHEN IMPLEMENTING PROCESS INNOVATIONS

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ABSTRACT

Does the use of DES differ when implementing novel production processes and technologies in the manufacturing industry? Addressing this question, this paper explores the use of DES during the design of production systems implementing process innovations. Data is drawn from a qualitative-based case study in the heavy vehicle industry where a process innovation was implemented in the form of a multi-product production systems. The findings of this study reveal novel findings related to the purpose and challenges in the use of DES models during the design of production systems when implementing process innovations.

1 INTRODUCTION

Discrete Event Simulation (DES) is an analysis technique whose results may be useful to decision-makers during Production System Design (PSD). Numerous studies highlight the importance of DES in PSD (Negahban and Smith 2014), yet recent studies indicate the need for increased decision support during PSD when implementing process innovations (Rönnberg 2019). Process innovations involve new technologies or production processes that differ significantly from the existing capabilities of a production system. Addressing this dearth of understanding is essential as process innovations are critical for creating strong competitive barriers leading to an increased market share. The purpose of this study to the use of DES during the design of production systems implementing process innovations.

2 METHODOLOGY

This study adopts a qualitative-based case study to elaborate on the current theory to meet its explorative purpose (Ketokivi and Choi 2014). The choice of case study research is justified by prior studies which describe its advantages for observing and describing a complicated research phenomenon in a way that increases understanding that quantitative data cannot easily reveal (Eisenhardt 1989). Empirical data is drawn from one PSD project at one global manufacturing company from the heavy vehicle industry. In this project the process innovation involved the implementation of a multi-product production system. Different techniques for data collection were used including field notes, interviews, and company documents to help obtain objective and reliable results.

3 RESULTS

Empirical data reveal that implementing a multi-product production system depended on a structured PSD process involving three phases: pre-study, concept design, and a detailed design. Staff responsible for the project utilized four DES models in these phases. These models included unique objectives and challenges described in Table 1.

Table 1: DES model use in the design of a production system implementing a process innovation.

Phase	Model description	Model purpose	DES challenges
Pre-study	**Model 1** - Visual representation of five alternative layouts	Enabling insight, conflict reconciliation, generating agreement, facilitating consensus, and layout selection	Incomplete and conflicting production system knowledge, translating problem into DES domain, low level of information
Concept design	**Model 2** - Evaluating conceptual production system	Dynamic representation of production process, acquiring information, evaluating operational performance, identifying improvements, initiating dialogue	Incomplete production system knowledge, specifying an appropriate level of model abstraction, absence of a real world representation
	Model 3 - Refining conceptual production system including assignment of resources in assembly area	Evaluating operational performance of alternative scenarios for resource assignment in assembly area	Incomplete production system knowledge, risk of incorrect assumptions, specifying the interrelation of subsystems in production
Detailed design	**Model 4** - Detailing production system and evaluating consequences of technical enablers	Synthesizing information from IT systems and on site tests, evaluating operational performance of production process	Meeting project conclusion on time and to budget, earning trust from design team and managerial staff

4 DISCUSSION AND FUTURE WORK

The findings of this study present valuable new insight for comprehending the use of DES in PSD when implementing process innovations. A first finding of this study includes the dynamic purposes of DES models in PSD when implementing process innovations. In the past, studies report the use of DES in PSD as a last step for verifying or evaluating an alternative. However, this study reveals that the purpose of DES models is not unequivocal, but adapts to the screening of ideas undertaken by manufacturing firms during PSD determining whether a process innovation is further developed or not. This study suggests that similar to the dynamic capabilities of production systems necessary for implementing a process innovation, which comprise learning, facilitating, and integrating new production processes, the use of DES may also adapt a continuous and dynamic approach in PSD. A second finding relates to the challenges of applying DES in PSD when implementing process innovations. Literature underscores the importance of DES for reducing uncertainty in PSD, and advocate the use of, for example, feasibility studies. However, results suggest that these contingencies may be insufficient, as challenges of DES in PSD comprehended incomplete and conflicting production system knowledge. The results underscore the need for increased efforts for reducing equivocal and uncertain information during the abstraction of DES models, an area that remains under researched. Our findings provide important managerial implications, and emphasizes the need for adapting and integrating DES related activities during PSD. Future research may include the confirmation of findings with additional cases and industry types.

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