

Chapter 73

Conceptualizing Emergency Department Scenarios: A DSE–Based Methodology

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ABSTRACT

To handle problems and trends in emergency department (ED) operations, designers and decision makers often simulate and evaluate various case-specific scenarios before testing them in a real-life environment. However, conceptualizing broad possible scenarios for ED operations prior to simulation operationalization is usually neglected. The authors developed a methodology that integrates design of simulation experiments (DSE) as follows: 1) From a literature survey, they culled generic factors whose varying levels determine possible scenarios; 2) the authors drew up a set of generic interactions among these generic factors; 3) a questionnaire was constructed to serve as an instrument to gather the relevant information from management staff about relevant factors, their levels and interactions for a specific ED. Questionnaire responses support a schematic conceptualization of scenarios that should be simulated for a specific ED. They illustrate the application of the authors' methodology for conceptualization of ED simulation scenarios in two different EDs.

INTRODUCTION

Service science is the study of service systems... combines organization and human understanding with business and technological understanding to categorize and explain the many types of service systems. The goal is to apply scientific understanding to advance our ability to design, improve, and scale service systems (Maglio & Spohrer, 2008).

Kaner et al. (2011) discussed the gaps between conceptual design of service processes and process execution (such as simulation and design of experiments) and applied their methodology to customer order handling process (a very simple service process). Such combination between concept developments with process simulation-based execution can be applied to other service systems (e.g., EDs).

DOI: 10.4018/978-1-4666-6339-8.ch073

The importance of conceptualization prior to system model operationalization in different domains (e.g., Luna-Reyers, 2003), including the healthcare domain, is widely recognized. “Conceptualization is at once the most important and least understood of all modeling activities. Conceptualization is really jargon for the...process of creating...*scenarios* to make the...act sound scientific, scholarly and repeatable” (Luna-Reyers, 2003), our *italics*. “A conceptualization is a...simple view of the world we want to represent. It is the mental process where the individual forms his/her understanding about a part of the reality” (Matook & Brown, 2008).

Simulation operationalization is the act of specifying exactly how a concept (e.g., an ED concept and/or scenario) is to be quantified, measured and simulated. Discrete-event simulation of emergency department (ED) processes is a rapidly expanding area within healthcare system engineering and management (e.g., Maull et al., 2009). Computer-based simulation scenarios, evaluated before their realization in a complex, real-life ED system, assist decision makers in improving existing ED operational performance or in designing new ED processes. Usually, simulations are used to generate futuristic viable scenarios that can assist management trying to avoid or resolve problems such as overcrowding, long patient length of stay, staff shortage, and budget constraints (e.g., Ahmed & Alkhamis, 2009). ED simulation settings and “what-if” scenarios (e.g., how will increases in the arrival volume influence capacity expansion decisions?) offered in the literature generally focus on the operational layer (e.g., Evans et al., 1996; Xu et al., 2008) and neglect to design simulation scenarios prior to ED simulation model development.

Conceptualizing scenarios through designing simulation experiments (DSE) improves process performance by a schematic approach rather than by trial-and-error simulation (Sanchez, 2006) or designer intuition (Takakuwa & Shiozaki, 2004).

Assigning factors or process components in DSE and then determining various factor levels, such that any configuration represents a simulation scenario, offers designers and users three main advantages.

First, the set of possible scenarios (e.g., fast track – to be applied or not; various possible percentages of internal patients, etc.) is almost infinite, encompassing many heterogeneous factors and their levels. DSE allows the designer to conceptualize and then formulate and simulate different scenarios in a schematic way through focusing on relevant factors and their levels. Second, beyond the analysis of individual factors, the effects of possible interactions (e.g., “fast track will reduce the patient length of stay only if the percentage of non-critical patients is higher than the defined threshold”) can be investigated. Third, integrating DSE in the early stages of simulation model development enables users to decide what data should be collected and allows “to-be” perceptions of the simulation scenarios. Focusing on heterogeneous factors and their interactions in a schematic way supports designers in conceiving and evaluating various operational improvements. For example, physician overloading can be resolved not only by increasing the current number of physicians (i.e., without changing the existing process) but also by adding a designated track (fast track) for non-critical patients (i.e., as a part of possible changes in the process structure).

Despite the above mentioned advantages, relatively few simulation applications present DSE for ED operations (e.g., Baesler & DaCosta, 2003; Appendix, last column) and those that exist are generally applied after specific simulation model development (Banks & Carson, 1995) and focus on a few capacity factors (e.g., Baesler & DaCosta, 2003).

Our aim is to facilitate simulation scenario conceptualization by integrating DSE through the schematic use of ED process generic factors, their levels and interactions.

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