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DISCRETE EVENT SIMULATION SCENARIO TESTING OF SCHEMATIC LAYOUTS IN AN EMERGENCY DEPARTMENT EXPANSION PROJECT

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ABSTRACT

Emergency department (ED) expansion and redesign is a complex design task which must take into account many operational processes (current and proposed) as well a projected changes in the system, e.g., patient volume. Discrete event simulation (DES) is a tool to aid the decision making process by simulating these processes; however, it's typically used in the operations or early design stages before many decisions are made about layout, capacity, and new processes. Later in the design process, the use of simulation can provide an avenue for what-if scenario testing of layout and programmatic changes. This presentation presents an initial discrete event simulation analysis of various layout options during the schematic design stage of an ED expansion project and provides a brief overview of future research directions evaluating decision making using discrete event simulation and visualization simulation.

1 INTRODUCTION

Research has shown that discrete event simulation (DES) analysis in healthcare is not enough to aid decision makers. Model acceptance and implementation are critical pieces missing from a majority of research investigating DES in healthcare (Günal and Pidd 2010; McGuire 1998). Research into model use has identified visualization of the system as a method to aid model understanding and thus potentially increase usability of DES (O'Keefe 2016). Both temporal and spatial simulations (DES and visualization) are believed by researchers to be helpful in aiding system understanding and communication. One area researchers have suggested for utilizing DES in combination with other visualization tools is during the schematic design of a new or renovated system (Gibson 2007). To build off these assertions, this presentation focuses on initial research into using DES during what-if scenario testing of layout options during schematic design of an emergency department (ED) expansion. This study is meant to fit into a larger body of research which investigates the role of using both discrete event simulation and visualization simulation in the schematic design decision making process.

2 METHODOLOGY

A case study of a high volume (60,000+ patients/yr) ED was used which currently is undergoing an initial phase of expansion and redesign. The project is a trauma 1 facility with current congestion and volume problems. A DES study was performed as a consulting service to the conceptual design firm in 2016. However, those services are not being used in the current schematic and design development phases of the expansion. The project team has created three alternative layout options and discussions with stakeholders have suggested the desire to test these solutions with a temporal simulation of operations.

Using the ED expansion case study, a new DES model is being created with the same data inputs and processes from the previous study using FY 2015 data and Simio software. Model conceptualization was developed based on workflow data from the ED nurses and doctors. For proposed future processes, a site

visit is scheduled with an ED facility currently implementing the proposed processes. A comparison of the base model will be performed with the existing conditions by comparing each performance metric to the mean performance of the existing system (Table 1). Four scenarios will modeled: conceptual design layout and the three alternate layouts including changes to distances between locations and waiting room capacities. For analysis, the following two research questions are proposed: (RQ1) Are the performance metrics in the alternative scenarios statistically different from the conceptual design layout's performance metrics? (RQ2) How far away is each system layout from a theoretical 'best' solution? In order to answer these questions, each metric will be evaluated using a selection of best methodology.

Table 1. Performance metrics of interest for ED Case Study including selection of the best goals

Metric	**Unit**	**FY'15 Data**	**Goal**
Average length of stay (LOS) overall	Hours	4.6	Lower is better
Average LOS for discharged patients	Hours	3.7	Lower is better
Average LOS for admitted patients	Hours	7.5	Lower is better
Time to provider	Minutes	n/a	Lower is better
Time to roomed in ED	Minutes	17.7	Lower is better
Percent of LOS > 3 hours	Percent	62.1%	Lower is better
Percent time to provider < 30 minutes	Percent	n/a	Bigger is better

3 RESULTS AND DISCUSSION

Currently, the scope of work is in the DES model building phase. The results will include the model validation and verification results as well as the what-if experimental design results for selection of the best scenario based on performance metrics. The results are expected to indicate how sensitive the DES model is to layout and operational changes, with a special emphasis on changes to intake processes. However, the results might indicate that other processes might need to be evaluated, such as lab turnaround time or in-patient bed availability, or that more specific task data is needed than used in earlier stages to understand how a layout will impact system performance.

DES provides an avenue to gain insight into complex systems such as emergency departments and can be implemented throughout the facility's lifecycle. Much of the research in healthcare DES has focused on process changes during operations and early design phases. What-if scenario testing of design layout options can potentially expand the use cases of DES simulations, thus providing a tool which can be leveraged to aid critical decision making processes. Implementation of a DES is only one step to aiding decision makers. This piece of work is meant to fit into a larger body of work which aims to understand how both temporal and spatial simulations can aid decision making in the schematic design phase of an emergency department. The next steps for this research are to develop various mockups of integrating DES output results with the spatial simulation and to perform an experiment evaluating model understanding and decision making when using both these simulation tools.

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