Estimating Key Performance Indicators of a New Emergency Department Model

Soraia Oueida, American University of Middle East, Kuwait, Kuwait
Seifedine Kadry, Beirut Arab University, Faculty of Sciences, Tarik AlJadida, Lebanon
Sorin Ionescu, Politehnica University of Bucharest, Bucharest, Romania

ABSTRACT

In this article, a real-life Emergency Department (ED) is studied and analyzed in order to propose areas for improvement in its operations and patient flow. EDs are in native very busy and complex systems where medical facility treatments are provided to arriving patients without any prior appointment. ED, a 24/7 open facility, interacts with the majority of other departments of the healthcare system. Due to this complexity and unplanned nature of patient surge, simulation modeling is proven to be very effective in order to study the necessary changes needed for better performance. As a consequence of these challenges, the patient LoS (Length of Stay) and the human-resource utilization rates are increased and thus leading to staff and customer dissatisfaction which need to be addressed for better performance. An emergency department of a hospital in Lebanon is chosen for simulation using Arena software where a model is designed to match the real system. This model is then verified, validated and enhanced by proposing some modifications in the resource allocation levels. These improvements are achieved by running different scenarios using Arena Process Analyzer and suggesting an optimal solution using Arena OptQuest tool without the need of interrupting the real system.

KEYWORDS

Arena, Cost Analysis, Model Optimization, Patient LoS, Simulation Modeling, Staff Utilization, Waiting Time

INTRODUCTION

Healthcare, being a necessity for all nations, is considered as one of the effective and essential entity for all societies, where care treatment is given to needed patients (Mifflin, 2007). The media and politics are given much more attention to the challenges faced by healthcare since it threatens the health status of the nation. These challenges can be listed as staffing shortages (“Nurse Staffing”, 2015; “Staffing Survey”, 2001), aging population (Hellmich, 2008), rising costs (Bodenheimer, 2005), and inefficient hospital processes (Berwick & Hackbarth, 2012). Simulation Modeling is proved through the literature to be the most effective way to model the daily operations of a queuing, concurrent system such as the emergency department. The system chosen for study is the one of a hospital in Lebanon currently suffering from large waiting times caused by resource shortages (equipment and manpower), absence of computer technology and the heterogeneity of insurance types. These problems caused a loss of potential revenue where patients tend to leave the system before being treated and overcrowding/bottleneck because of the high length of stay; thus, leading to patient dissatisfaction and sometimes may affect patient’s safety. The system is studied and analyzed using several methods in order to establish a comprehensive and solid view of the ED operation:

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collecting real data, conducting interviews with staff/patients and site visits’ observations. Based on that, the model is designed, verified and validated leading to a reliable system. Patient flow is then improved using simulation experimentation and optimization techniques.

In order to ensure better process performance and provide efficient services to patients, always maintaining a high level of safety, improvements can be suggested by identifying new resource flow and allocation. Challenges arise here because of the various acuity levels of patients, the numerous ED processes and its different service time. Simulation modeling was proven to be efficient to combat such challenges and provide realistic results. Without interruption of the real system operations, a model can be designed to detect and imitate the flow of resources and patients through the system. Then, changes can be suggested to any process and effects can be easily analyzed before being applied. Using simulation, constraints, bottlenecks, and inefficiencies can be identified and combated thus guaranteeing patient and management satisfaction. The studied ED faces common issues in the healthcare industry: staffing shortage and inefficient operations. The ED is constituted of two different emergency rooms located in two different buildings and sharing some facilities, such as radiology and billing. This leads to patients’ large waiting time and high staff utilization rates. Furthermore, this hospital suffers from the existence of various insurance coverage types which imposes on the billing department to deal with different insurance companies and indirectly affects the patient flow in the ED.

This journal is organized as follows: an introduction is presented in section 1 then a hospital background in section 2. Section 3, 4 and 5 represent the methodology followed in order to accomplish this project; including data collection and analysis, designing the Arena model and testing it in order to verify its functionality and validity, and output results. In section 6, experimentation is performed and different scenarios are suggested in order to explore the effects of changing specific metrics in the ED and areas for future improvement are suggested. In section 7, model optimization is performed using Arena OptQuest. Finally, the journal is concluded in section 8 and future work perspectives are suggested.

HOSPITAL BACKGROUND

The chosen ED is an emergency department for a hospital in Lebanon. It is a non-profit health institution recognized since 1952. Since this hospital was the only shelter for public services during the Lebanese Civil War (1975-1990) and because of the increasing number of patients, an extension became a must. Many achievements have been realized since then to expand the hospital and include new departments. In 2003, a new building was established in order to serve more beds and extend the hospital facilities. The two buildings were connected through an underground tunnel in order to safely transfer patients. The first building is a charitable suite building while the second one is a private suite building. Nevertheless, both buildings can serve all patients in need in case of overcrowding. The hospital includes almost 200 beds and covering most of the medical/surgical specialties. Its ED serves more than 40 000 patients yearly and open for 24/7. The main ED resources are classified as per the following:

- **Emergency Room Doctor (ER Dr.):** Responsible for high level decisions, final diagnosis, writing prescriptions, ordering extra facilities or special treatments.
- **Registered Nurse (RN):** Responsible for all triage activities once patient arrives to the ED. RN can make some decisions instead of the ER doctor in case of exceptional conditions like bottleneck or disaster conditions. RN is the chief of all nurses.
- **Nurse (N):** Responsible for collecting patients’ data information once he enters the ED. The nurse is also responsible for preparing the patient until the doctor is available.
- **Transporter:** Responsible for transferring the patients to other units in case needed.
- **Specialist:** Responsible for extra diagnosis and assisting the ER doctor with final decisions if needed. Specialists are available in their clinics and are common for all the hospital.
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