**International Journal of Decision Support System Technology**
Volume 14 • Issue 1

# Specifications of a Queuing Model-Driven Decision Support System for Predicting the Healthcare Performance Indicators Pertaining to the Patient Flow

Ashraf Ahmed Fadelelmoula, Prince Sattam bin Abdulaziz University, Saudi Arabia*

## ABSTRACT

This article has developed specifications for a new model-driven decision-support system (DSS) that aids the key stakeholders of public hospitals in estimating and tracking a set of crucial performance indicators pertaining to the patients flow. The developed specifications have considered several requirements for ensuring an effective system, including tracking the performance indicator on the level of the entire patients flow system, paying attention to the dynamic change of the values of the indicator's parameters, and considering the heterogeneity of the patients. According to these requirements, the major components of the proposed system, which include a comprehensive object-based queuing model and an object-oriented database, have been specified. In addition to these components, the system comprises the equations that produce the required predictions. From the system output perspective, these predictions act as a foundation for evaluating the performance indicators as well as developing policies for managing the patient flow in the public hospitals.

## KEYWORDS

Decision Support Systems, Model-Driven DSSs, Object-Oriented Database, Patient Flow, Performance Indicator, Queuing Model

## 1. INTRODUCTION

The recent years have witnessed a great amount of research efforts to augment and enhance the management practices in the healthcare industry. A considerable part of these efforts has been devoted to the patients flow among the provided healthcare processes and services in the health units (hospitals, health centers, etc.) (e.g., Armony et al., 2015; Bean, Taylor, & Dobson, 2017; Dong & Perry, 2018; Fitzgerald, Pelletier, & Reznek, 2017; Vass & Szabo, 2015). These processes and services represent facilities that should be managed carefully in order to improve the patients flow. Improving such flow can result in providing a sufficient care to the admitted patients as well as achieving their satisfaction (Armony et al., 2015). An important aspect of the careful management of these facilities is tracking their performance with respect to many dimensions relating to the patients flow. These dimensions comprise the patient waiting times to benefit from these facilities, response times of these facilities, number of patients waiting in the queues of these facilities, number of patients served, utilization of these facilities, and patient satisfaction (Aziati & Hamdan, 2018; Hall, Belson, Murali, & Dessouky, 2013; Hu, Barnes, & Golden, 2018). Most of these dimensions are linked to the healthcare delivery

DOI: 10.4018/IJDSST.286676 *Corresponding Author

quality. For instance, Cerda´, Pablos, & Rodriguez (2013) included the usage of the length of the waiting lists as a measure of the quality of the health system.

Accordingly, effective tools that aid the healthcare decision makers in tracking and improving the aspects of these dimensions are highly needed. Fulfilling this need has not received a wide attention on the level of the patients flow in the public hospitals. This is because the majority of the previous studies have focused on proposing tools on the level of the clinical decision making, indicating that these tools are directed to aid in the diagnosis and treatment of diseases (e.g., Cánovas-Segura, Campos, Morales, Juarez, & Palacios, 2016; Gudmundsson, Hansen, Halldorsson, Ludviksson, & Gudbjornsson, 2019; Sim, Ban, Tan, Sethi, & Loh, 2017; Yılmaz & Ozdemir, 2017).

Consequently, the present study responds to this need by developing specifications for a new decision support system (DSS) that provides the key stakeholders of the public hospitals with the required estimates for a set of crucial performance indicators pertaining to the patients flow. Producing these estimates is specifically vital for predicting the performance dimensions, supporting the decision making process, and improving the administrative processes in these hospitals. Moreover, these estimates are highly required due to the difficulty in knowing and tracking the actual values of those performance indicators. This difficulty stems from an observed lack in many public hospitals, which is that the events pertaining to the patients' movements among the provided facilities as well as those related to their treatments and tests are either not well registered and time stamped or not given attention at all. In this regard, Hall et al. (2013) pointed out that many hospitals have encountered difficulties in making these estimates due to using inadequate information systems or not having the required resources to develop and implement the needed information systems.

To ensure the effectiveness of the proposed DSS, the present study considers a set of requirements as follows. The first requirement is that the DSS should be based on an accurate comprehensive model for representing the patients flow through the hospital's facilities. Comprehensive means that it should include all facilities that the patients encounter during their treatment path. The second requirement is that the system should consider the diversity of the patient categories. In the healthcare environment, the patients are generally classified into several categories, including emergency patients and non-emergency patients (Ferrand, Magazine, Rao, & Glass, 2018; Lin, Patrick, & Labeau, 2014; Siddharthan, Jones, & Johnson, 1996; Tan, Wang, & Lau, 2012). Consequently, the system should track the performance dimensions for these categories. The third requirement is considering the variability of the patients flow and treating among the provided healthcare facilities. This variability implies deriving generic estimations for the performance indicators that can be applied for each individual facility, and then aggregating these estimations to produce their mean values on the collective level of these facilities. The last requirement is that providing accurate estimates requires considering the dynamic change of the arrival and service patterns of the patients, including the change of their arrival and service rates over time.

These requirements originate from several gaps in the literature of the patients flow performance. Among these gaps is that most of the previous studies focused on assessing the performance indicators in specific healthcare facilities (e.g., emergency department (Vass & Szabo, 2015), primary healthcare clinic (Azraii, Kamaruddin, & Ariffin, 2017), and cancer treatment center (Suss, Bhuiyan, Demirli, & Batist, 2017)). Hence, providing a generic solution for tracking these indicators that can be applied to a wide variety of facilities was not given the required attention. In this context, Armony et al. (2015) and Creemers, Lambrecht, and Vandaele (2007) pointed out the wide concentration of the patients flow literature on only some parts of the hospital rather than its entire system, thereby indicating the ignorance of the influences of interactions among these parts on the hospital's performance indicators. A second lack is that the possibility that the patterns of patients' arrival and service rate may change over the time was not considered in the majority of the prior studies (Fomundam & Herrmann, 2007; Singh, 2006). Lastly, many previous studies have not considered any classification of patients, which goes against the common practice in the healthcare area that the patients are assigned to different