Chapter 12
A Forecasting Model for Patient Arrivals of an Emergency Department in Healthcare Management Systems

Melih Yucesan
Munzur University, Turkey

Muhammet Gul
Munzur University, Turkey

Suleyman Mete
Munzur University, Turkey

Erkan Celik
Munzur University, Turkey

ABSTRACT

Emergency departments (EDs) are one of the most valuable departments of healthcare management systems. Patient arrivals at the EDs are crucial for planning of the future. Accurate forecasting of patient arrivals contributes to better organized human resources and medical devices in the EDs. Therefore, in this chapter, the authors aim to develop a hybrid model including the methods of autoregressive integrated moving average with external variables (ARIMAX) and artificial neural network (ANN) in a hospital ED. The arrival data was collected from the hospital information system of a public hospital in eastern Turkey. The model incorporates factors related to ED arrivals such as climatic and calendar variables. By the aid of the proposed model, an insight to arrangement and planning of ED resources can be provided in a better way.

INTRODUCTION

Forecasting can be expressed as making predictions at times when the results are not observable in the present situation. Forecasting play an important role in making short and long-term decisions (Armstrong, 2001; Qin and Shi, 2006). In all societies, the level of population access of health resources is directly related to the well-being of the community. One of the most important part of the National Health System is hospitals which has special technologies, advanced equipment and also healthcare personnel (Carvalho-Silva et al. 2017). Emergency departments (EDs) are one of the most valued parts of the healthcare management systems. It has to provide adequate, immediate and accurate healthcare management (Hoot et al. 2007). Performance determiners for service quality through EDs are related with length of stay (LOS) and waiting times, which are affected by high levels of ED arrivals (Xu et al. 2013). The number of patients who will come to the EDs and the waiting times will be one of the most important input parameters in the planning of the investments and arrangements to be made in the ED in the future (Pianykh and Rosenthal, 2015). Compared with other departments of the hospitals, the ED is clearly the more crowded than other departments (Gul et al. 2017). One of the most important factors that cannot predicted in emergency services is the time of arrival of the patients. The number of future patients which need to health care to the ED service is directly related to the various independent variables and the number of patients coming in per day in the past period (Xu et. al. 2016; Hertzum, 2017). Accurate forecasts of patient arrivals which need immediate health care contribute to better organized human resources and medical devices in EDs (Aladeemy et al. 2016).

On the other hand, time has important effects on the performance of EDs. It is measured and analyzed for suitable evaluation of ED performances. Patient arrivals are one of the important process of EDs in healthcare management systems (Gul and Guneri, 2015a). Long wait and overcrowding in ED processes is increased in recent years which directly affect the quality of ED performances. These processes have the potential to improve ED throughput and patient pleasure if these are efficiently fulfilment. Because of delay within time related processes have potential to effect overcrowding in the EDs, it gets significant must to be forecasted and known time by means of prevent from the delays. Statistical forecasting considered as an operation research technique that uses time series data and a kind of statistical formulae and data mining approaches to forecast different types of ED processes. The more researches are needed for more exact planning due to improvement of forecasting models. It helps to decrease of overcrowding linked to other hospital units and external world (Wargon et al. 2009).

In this chapter, we aim to develop a hybrid model including the methods ARIMAX and ANN for patient arrivals of a hospital ED. By the aid of the proposed model, an insight to the doctors and administrator staff for planning of ED resources will be provided in a better way. Our ultimate goal is to provide ED stakeholders with a background on the ED as healthcare management systems and a hybrid statistical forecasting method that can be practically applied to various ED processes. This chapter will contribute to the literature by the following aspects: *(i)* To the best of our knowledge, there is no studies that have used the ARIMAX-ANN hybrid model to forecast ED arrivals in Turkey, *(ii)* The model includes not only calendar factors but also climate factors and some special factors (weekend and public holidays) in forecasting ED arrivals, *(iii)* By the proposed model, it will be proved that using the ARIMAX-ANN hybridization is applicable for forecasting of ED patient arrival forecasting and helping in arrangement and planning of ED resources.

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