

Determining shift schedules for 24-hour queuing systems with time-varying arrival rates *Applied on the ED of a university medical centre*

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Author: Arnoud de Bruin
Organisation: VU university medical centre & VU university

General description

This assignment is about determining shift schedules for systems with arrival and service rates which vary across a day. A shift is specified by start time and shift duration (e.g. a 10-hours shift starting at 8 AM). The overall problem is to find a set of shifts for physicians which minimize the average waiting time of patients. An application would be to determine physician shifts for covering a 24-hour emergency room or first cardiac aid. See Fig. 1 for a typical ED arrival pattern and service time distribution.

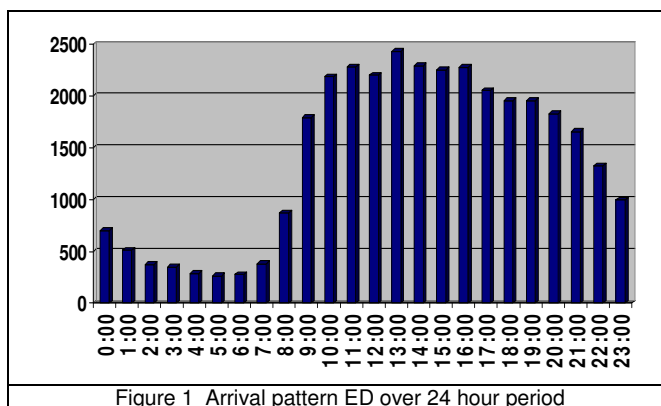


Figure 1 Arrival pattern ED over 24 hour period

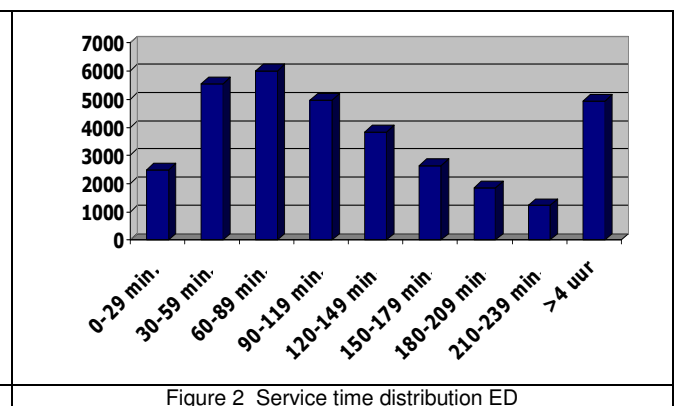


Figure 2 Service time distribution ED

Literature reference

“Since the M/M/s model assumes that the arrival rate does not change over the day, actual service systems that have time-varying demands (such as an ED) typically use this model as part of a SIPP (stationary independent period-by-period) approach to determine how to vary staffing to meet changing demand. The SIPP approach begins by dividing the workday into staffing periods, e.g. one, two, four or eight hours. Then a series of M/M/s models are constructed for each staffing period.....”

“However, recent research has shown that the SIPP approach is often unreliable, particularly when average service times are 30 minutes or more, and that a simple modification, called *Lag SIPP* approach is often more effective in identifying staffing levels that achieve the desired performance standard. This is because in many service systems with time-varying arrival rates, the time of peak congestion significantly lags the time of peak in the arrival rate”.....

Linda Green (2006), *Queuing analysis in healthcare, Chapter 10, Patient flow: reducing delay in healthcare delivery 281-307 (Hall, Springer)*

Goal

1. Develop a model to determine appropriate staffing levels per hour. The (minimum) required inputs are the average arrival rates by hour, the average service time and the service time distribution. The user can determine staffing levels by hour given a required service-level (e.g average patient waiting time, % of patient waiting < min). The output of this first step is the required staffing level by hour to achieve the desired level of queuing performance.
2. Find the set of shifts which meets the required staffing level by hour while minimizing the total number of staffing hours.

Output requirements

The models have to be user-friendly and technologically accessible.

An internet version (see example at <http://www.math.vu.nl/~awattel/agents.php>) is required