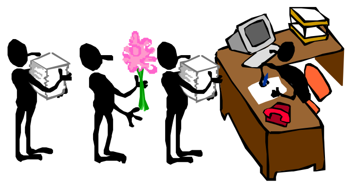
HSOR NEWS
*The evidence behind your decisions*
Health Services & Outcomes Research, **Issue 2009/1**

## What is Decision Science?

Decision Science is the use of quantitative techniques to support intuition, with facts based decision making. Principles of probability and operations research are used to develop insights from data.

## Applications of Decision Science in healthcare



- **Variability Management** – while variability is inherent due to patients' uniqueness and the urgency of patient's needs, the healthcare delivery process itself often creates variability, such as batching of jobs. This leads to additional service capacity, or results in longer waiting. A good understanding of variability in care delivery helps us to manage the trade offs among service variability, patient queues and system utilisation. Queueing theory, for example, allows us to study the impact of ring-fencing on the queues.
- **Planning and Decision Support** – scarce manpower, capital and infrastructure resources have to be efficiently and equitably allocated to meet multiple stakeholder objectives. Optimisation analysis provides a framework and tools to allocate resources optimally and satisfy competing constraints, for example, in the optimisation of bed allocation to reduce overflow.
- **Clinical Decision Modelling** – patient variety, clinicians' experience and knowledge, as well as environmental and situational stressors make clinical decision-making a complex and tough mission. Clinical decision modelling is an iterative process of sifting and synthesising information to discover the underlying trends, relationships and rules for better decision making and implementation. The development of a better pneumonia management algorithm that improves patient outcomes is an example.

**WHAT'S IN THIS ISSUE**

This is a first of the 3 series on Decision Science in healthcare. In this issue, we will introduce queueing, focusing on 2 topics: trade-off in queue management and effects of partitioning.

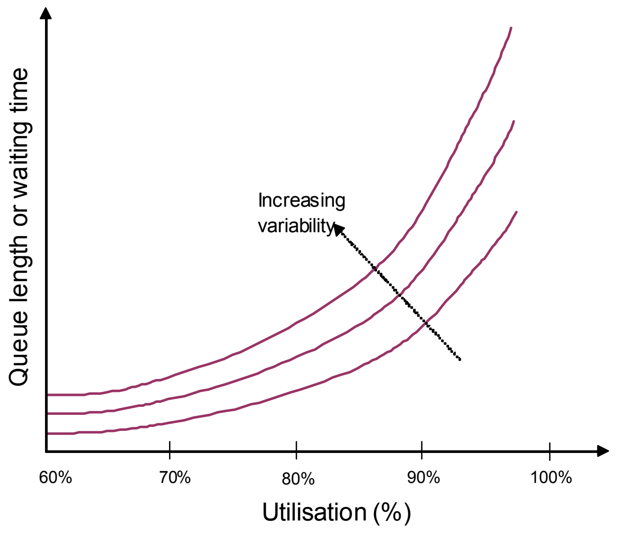
In this issue we introduce Decision Science and focus on queue management.

## Variability, queues and utilisation

Queues are commonplace, but all queues are not line-ups behind a counter. It can be an A&E patient waiting for admission, outpatients waiting for their first appointment, or a batch of blood test order waiting for processing. **Queues can happen even when supply is greater than the demand.** Doctors may serve faster than patients arrive, but a queue may still build up. Patients may come in at different times (even if scheduled) and consult time varies. The variation in both the service and arrival is the cause of queues. In simple cases, queueing theory is used to predict the average number of patients and average patient waiting time in the clinic. Otherwise simulation tools are used.

Assume that a GP typically takes 10 minutes to see a patient (6 patients/hour) and that his patients walk in at an average rate of 4/hour. **While the capacity is larger than demand, patients typically still need to wait.** In fact, we can use a queueing formula (known as M/M/1) and compute the queue statistics: an average of 2 patients in the clinic, and average waiting time of 20 minutes. In fact, the higher the utilisation is, the longer will be the queues and queueing time.

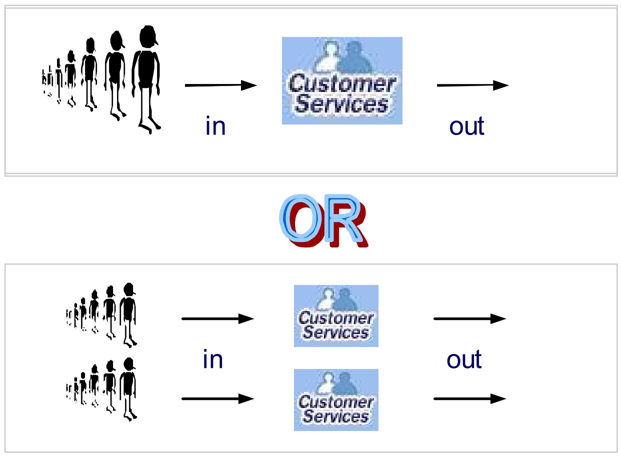
The ideal situation is to have few or no queues and high utilisation. However, these 2 are inherent trade-offs. Queueing relationship, as plotted on the right, tells us that **queues/waiting time increase exponentially with utilisation.** Also, **for the same utilisation level, the waiting time also gets higher when the variability increases.** Thus, one way to reduce waiting time with the same capacity and demand is to reduce variability of the process — which is also what is preached in Lean management!




## Partitions increase queues

*A long line for a shorter wait at the supermarket*
http://www.nytimes.com/2007/06/23/business/23checkout.html,

The New York Times, 23 June 2007: "For its first stores here, Whole Foods, the gourmet supermarket, directs customers to form serpentine single lines that feed into a passel of cash registers. Banks have used a similar system for decades. But supermarkets, fearing a long line will scare off shoppers, have generally favored the one-line-per-register system. By 7 p.m. on a weeknight, the lines at each of the four Whole Foods stores in Manhattan can be 50 deep, but they zip along faster than most lines with 10 shoppers. The science of keeping lines moving, known as queue management, is a big deal to big business."




## *What can we learn?*

Queueing theory illustrates that **with the same total workload and service providers, a system with less partitioning will have lower waiting time at the same utilisation level.**

Can we apply this concept to healthcare services planning? Yes. For instance, when wards are full, we may find that we actually have the beds, but for the wrong gender. This is an example of partitioning — but one which is necessary.

Partitioning is therefore a trade-off between better customer service (e.g. two smaller pharmacies located nearer to clinics rather than a centralised one), or specialisation (e.g. specialty differentiation) with resource utilisation and waiting time.

Look out for our *Operations Research Appreciation Course*, 19-20 Jan 2009 in which we will cover queueing and other operations research topics in more detail!

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Pal and KL are Operations Research Specialists with extensive experience in defence OR and have done several projects in healthcare such as using optimization tools to reduce variability, support infrastructural planning, and training to build capability in OR among NHG staff.