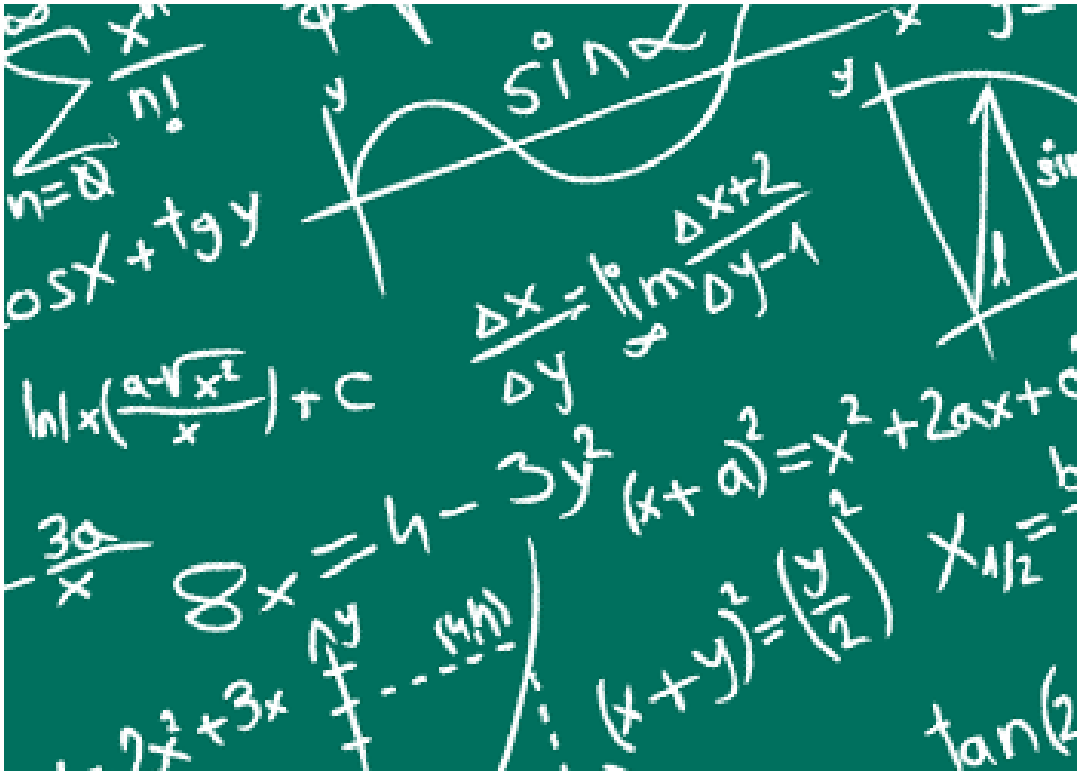
The Equation of Lean

Understanding Queues & Variation

Simon Elias



If you are involved in service delivery, it is highly likely that at some point you manage queues. But how many of us really understand how to control them? The equation of lean helps us appreciate what is happening and provides direction for their effective management and is linked to the core management competency of understanding variation.

"I'M SORRY, BUT ALL OUR AGENTS ARE BUSY AT THE MOMENT…"

We've all experienced this apologetic message on a Monday morning when we call a service centre to make that claim, book an appointment, or request service. They are experiencing "high levels of demand" and you're invited to go to a website, or call back when its less busy or simply hold on …and naturally, they really do "value your custom".

Of course, if they really valued my custom they would find out that what I value is a short queue, so I do not wait long for someone to answer my call, who has the capability to address my query or solve my problem quickly.

You also get the impression that they are genuinely shocked by the call volumes on that particular morning and they are pulling out all the stops to keep the show on the road and reduce the queue. However, the question persists 'do they really understand the nature of queues and are they doing anything about them?'.

QUEUES

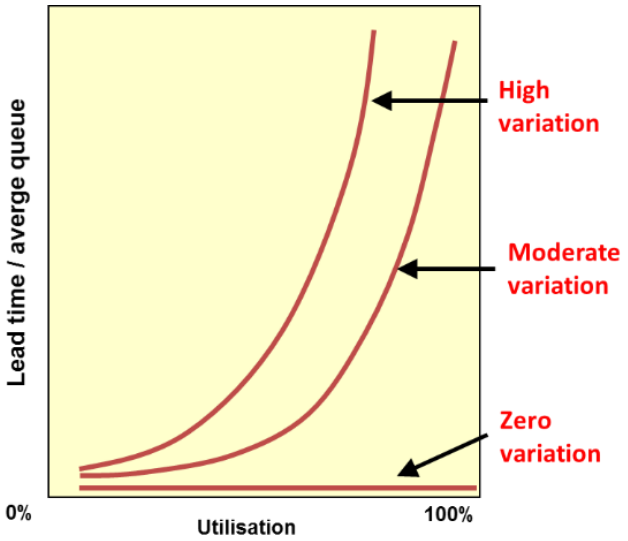
Understanding the nature of queues should be a key concern of any service operations manager, since demand will never be even and service processing times will never be the same. Queues are therefore highly prevalent in all forms of service and have the potential to create waste and negatively impacting flow, quality, customer satisfaction, cost and ultimately competitiveness and profitability.

John Bicheno has long focused on queues and their impact and provides a full discussion in The Service System Toolbox, as well as promoting several dice games that illustrate the principles clearly and simply. John focusses on Kingman's Equation as a means to understand queuing phenomena and has labelled it the equation of lean due to its significance and the insights it can bring for managing lean service operations.

While you do not necessarily need to immerse yourself into the statistics behind the equation, familiarity with its fundamental components is critical. Put simply, Kingman's equation states that three variables influence the length of the queue, which are:

- Arrival variation
- Process variation
- Utilisation

The graph shows the queuing theory relationships, where the vertical axis is average queue length, the horizontal axis shows capacity utilisation (that is, average arrival rate divided by average service rate).



Key points to note about the graph are:

- Queues approach zero when there is plenty of capacity.
- Queues get worse when arrival rate of customers nears the capacity, which means the curve is exponential not linear: so the busier its gets, the worse the queue.
- When demand is about 80% of capacity, the queuing problems start, so as a rule of thumb,

you need 25% more capacity than demand to provide a reasonable service.

- Working at higher utilisation will clearly risk upsetting customers.
- If there is no variation, the average queue time will be zero.
- The range or uncertainty in queue length is highly dependent on utilisation; when it is low the range is small, when it is high wait time in the queue is highly unpredictable.

Note that the aforementioned dice game will produce an output similar to the graph above, clearly illustrating the queuing, as well as the immutable power of the laws of statistics.

So on that Monday morning in the call centre, as demand exceeded 80% of capacity, waiting times started increasing rapidly and service levels nosedived and the apologetic voice message kicked in. Any manager or his accountant colleague who thinks the operation could operate at 100% capacity does not appreciate the statistical reality.

VARIATION & FLOW

A key lesson from Kingman's Equation is that variation is the enemy of flow and if we can reduce both arrival variation and process variation, we will be able to process more, even if we have less capacity.

There is a wide array of methods to control arrival variation, including off-peak pricing, extending opening hours and special offers, scheduling appointments, moving low priority work to quiet times, though many businesses actually make matters worse by offering quantity discounts or having sales targets that result in an end of month activity peak.

However, most of the time in many sectors there is a predictable pattern to demand volumes and it is only due to 'special cause' events that things change.

Process variation can be narrowed by tactics including improved staff flexibility, specific training, better qualified operators, smaller batch sizes, adopting a right-first-time mind-set, reducing product variants, better customer communication, six sigma tools and standard work.

The latter is popular due to its status in the traditional lean toolbox, though too much standardisation risks causing high levels of failure demand and an inability to meet customer needs, since it can prevent the system from being able to absorb the natural customer demand variety that is an innate feature of services.

This tends to be different in manufacturing, where the aim is try and remove process variation completely, as well as adopting load levelling approaches like Heijunka.

IMPLICATIONS FOR LEAN MANAGERS

An understanding queues, what causes queue length and a recognition of statistical variation is a critical competency of a service manager. Indeed, one of the five key leadership competencies that the LCS suggests as part of its framework is the ability to problem solve, understand variability and waste.

Kingman's Equation draws attention to the relationship between three of Toyota's chief concerns, namely Muda (waste), Mura (unevenness) and Muri (overburden), which are interlinked and together enable a better understanding of lean, and of course the latter two are a particular issue in services.

A further implication is that a prime focus for a lean service improvement team should be on demand analysis and understanding, both in term of demand volumes and the nature of what customers require.

In particular, this will enable a focus on failure demand (that is, demand from customers caused by a failure to do something right the first time and the opposite of the value demand you want). Reducing failure demand can have a significant impact on queue length.

The challenge for the service manager is to decide on the right cost:service level trade-off that reflects customer expectations and the overall service proposition being put to the customer.

Allocating resources to provide extra capacity may improve the quality of service, but that comes at a high price, which the customer may not be prepared to pay. It may lead to development of different products offering varying levels of service to different market segments, or focusing on what Kano refers to as performance and linear product attributes ("more is better") for which customers are prepared to pay more.

In making such decisions, what is clear is that the service manager should have some idea where they are on the Kingman Equation curve so they can plan effectively and get a better appreciation of the system in which they are operating.

As for that recorded message received while in the Monday morning queue, perhaps it should more accurately state "good morning; today we have made a business decision to commit a level of resources to answering the phones that, given the high call demand that we knew was coming, will result is you waiting a long time in a queue. Hard luck, but it keeps costs down!"

Reference & Further Reading

The Service Systems Toolbox, John Bicheno (2011)

The Lean Games and Simulations Book, John Bicheno (2014)

About the Author

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Simon is Director of Lean Competency Services Ltd, launched in 2014, which holds the Cardiff University licence to operate the Lean Competency System, of which he was the chief architect. He was previously director of the Lean Enterprise Research Centre, Cardiff University, which he joined in 1997. Prior to that he had a career in marketing management, research and planning, with Johnson Controls Inc, The Automobile Association, Compass and Thorn EMI. He has a masters in marketing from the City University Business School, London and professional qualifications in marketing and market research.

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Published February 2016

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