

Capacity and demand management



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Introduction

Good decision-making relies on having the right information presented in the right way. That information comes as data that we obtain either through extraction from existing records or newly collected information that we have gathered for the purpose of decision-making. This makes data analysis one important skill when decision-making. In this course you will take a look at capacity planning decisions as an example of effective data use.

It seems obvious that resource plans should not be created without an understanding of the demand for resource, but you will find that demand is not always measured, or collated in a way that is not helpful to decision-making. This course provides a range of perspectives of how data can be understood, in the context of managing capacity and demand.

After completing this course, you will be able to:

- understand how useful data can be to inform practical decision-making
- see how demand patterns are derived when looking at data
- understand how seasonal patterns in demand are caused and how this impacts on resource planning
- understand different perspectives of how demand for services can be assessed
- see how demand data can be used to plan capacity requirements.

1 Criminological perspectives of demand

One way of understanding demand for much policing activity comes through criminology – the scientific study of crime. At the simplest level, it is useful to know what types of crime occur and how frequently they are committed. For example, crime statistics in England and Wales show the following most commonly reported crimes:

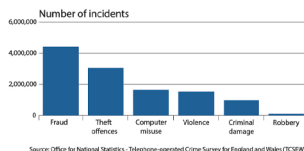


Figure 1 TCSEW estimated 3.1m theft offences in the last 12 months. (England and Wales, based on interviews conducted between May and December 2020.)

Activity 1 Crime statistics

Allow approximately 5 minutes

How do these crime statistics help plan policing capacity? What are their limits of how they help?

Provide your answer...

Discussion

The crime statistics can act as a guide to what crimes police deal with and the skill sets needed within forces to deal with those crimes. The statistics are also useful when observed over time as trends in crime types can be observed. Planning can then address how to reduce or prevent these crimes or look at increasing particular skill sets.

There are a number of limitations. First the statistics themselves can only be a guide as much crime is unreported. Secondly, up to 80% of police work is not crime-related (Boulton, L. *et al.*, 2017) so when we look at decisions such as numbers of police needed we are missing most of the workload. Thirdly, it does not usually tell us when or where officers are needed.

The next section looks at an alternative way of understanding patterns in crime.

2 Crime pattern theory

Criminologists can look at why crimes occur and both where and when they happen. Crime pattern theory looks at the geometry of where crime occurs, based around the notion of where crime activity takes place and how offenders travel through likely places for crime and develop knowledge of those locations.

Activity 2 Locations of crime

Allow approximately 5 minutes

Reflect on your own known locations for crime or other police demand. Are there different locations dependent on the time of day?

Provide your answer...

Discussion

Most of this would be personal to your situation but there are some obvious night-time economy sources of demand (public order and violence) which will occur in specific locations.

This type of analysis helps us understand demand from a policing perspective. In the next section we see how we can take a management perspective to understanding demand.

3 Managerial perspectives of demand

In this section we take a look at some of the managerial perspectives of demand and capacity which focuses on understanding demand for decision-making.

Activity 3 Capacity management

Allow approximately 10 minutes

Pick any service that you are familiar with, such as a supermarket, airport or restaurant.

Imagine that service in a situation where it does not have anywhere near enough capacity to meet demand. What sorts of things will go wrong? How will the capacity shortage affect the efficiency of the service?



Figure 2 People queuing inside an airport

Now imagine the same service but with far too much capacity. Is this a better position to be in? Will it be efficient?



Figure 3 Airport car park

Provide your answer...

Discussion

A service that is short of capacity will clearly have some very visible problems of queues and delays. We've often been in a position of queueing for hours to check in for a flight, been crammed into a train with no room, told that there is no table at the restaurant and so on. The performance of such services often rapidly declines once demand significantly exceeds (or even closely matches) the capacity to serve customers. In many cases the service quality suffers and staff become more stressed, often making the situation worse in the long run. In emergency services the response time to go to incidents rapidly declines when there is a shortage of capacity.

Services that have excess capacity sometimes also experience problems. For example, the atmosphere in an empty restaurant can be uncomfortable, especially if

the staff are constantly hovering over you. Sometimes the service seems too rushed. Staff motivation can suffer if they don't have enough to do. There is also the obvious problem that there is a lot of waste of resources, both in terms of under-utilised staff but possibly wasted food etc. For emergency services the responsiveness can be good, at a cost of sometimes unused staff.

Given these two extremes, is there a balancing point where capacity is enough to do the job without there being excess wasted resource and maintaining good quality?

4 Policing decision-making

One technique that can be used to analyse local policing demand blends the SARA decision-making model of policing with demand analysis. The example below shows how a demand problem might be broken down into steps:

1. **Scanning** What are the recurring problems of concern to the public and police?
Can we confirm the problem exists?
Do we know how frequently the problem occurs?
2. **Analysis** What data do we need to analyse the problem and derive solutions?
What ideas do we test to see why the problem is occurring?
3. **Response** What interventions to reduce the problem can we test?
Do we have a plan to implement solutions and test their effectiveness?
4. **Assessment** Did our interventions work?
What evidence do we have to understand how well our interventions worked?
Do we need to do more work?

This approach can be used to identify many types of demand problems in policing, such as:

- Understanding the nature and scale of repeat offending
- Identifying where people are repeat victims and why this is the case
- Repeat locations
- Anti-social behaviour

Case study: Repeat attendances at A&E

In November 2021 the BBC reported new analysis by the British Red Cross of NHS data on regular Attendance at A&E departments. They discovered that less than 1% of the population account for 16% of all A&E attendances, with just 0.7% of the population accounting for 29% of ambulance journeys and 26% of unplanned hospital admissions. The data also showed that many of the regular attenders were dealing with 'mental health problems, relationship breakdown, housing insecurity or loneliness.'

[Some vulnerable people use A&E weekly or more BBC News](https://www.bbc.com/news/health-58888888)
[hiu-summary-report-final.pdf \(redcross.org.uk\)](https://www.redcross.org.uk/hiu-summary-report-final.pdf)

Activity 4 Accessing services

Allow approximately 5 minutes

Think about your own work. Do you come into contact with people who regularly access services for similar reasons or problems such as drug addiction?

Provide your answer...

The next section looks at how we can apply the SARA decision-making model to help us understand demand management problems.

5 Understanding time perspectives with capacity and demand decisions

Capacity planning is a process of understanding demand and organising the right resources to meet the demand cost effectively. Conventional approaches divide the capacity management tasks into three time horizons:

1. **Long-term planning** (18 month or more time horizon):

Long-term planning usually involves the planning of new facilities or locations and sometimes the recruitment and training of specialist staff. For example, the NHS has to plan the training of doctors many years in advance as it takes over 8 years to train and provide enough work experience to develop a new junior doctor.

2. **Medium-term planning** (3-18 month time horizon):

When you look at demand patterns over a year or so you will usually see seasonal patterns to demand that require any operation to make adjustments to the availability of resources over that time, with peaks and troughs in demand. Organisations have to develop plans, such as shift patterns, hiring of seasonal or temporary staff etc. to be able to cope with these fluctuations.

3. **Short-term planning** (less than 3-month planning):

Much of the planning work is to ensure that the right people are available at the right time and place. Often this is a scheduling role – which often also needs to include some reactive work to cope with unexpected events.

Activity 5 Capacity planning

Allow approximately 5 minutes

Think about how far in advance you may have to look if you are to plan for the following types of decisions:

- Building a new facility such as a police contact centre
- The full training and development of highly skilled and specialist staff

Discussion

Both of these decisions would come under long-term planning as the time horizon in each case is many years. In the case of the new facility it can take many years to obtain the right permissions and funding. To develop a highly skilled workforce again the lead time can be many years through degree education and then training. This can present problems as situations can change, leading to over- or under-supply of critical resources.

The next section looks at the influence of timescales on how demand and capacity decisions are made.

6 Demand Analysis: four components of demand

Simple models of demand break down the total demand into four components:

1. **Long-term growth or decline patterns** Demand is rarely completely stable. We often find that some types of demand are undergoing growth and others have significant declines over time. There can be “life-cycle” models of demand where demand for something grows, stabilises and later falls again.
2. **Cyclical or seasonal patterns** Most demand is cyclical in some way – going through peaks and troughs – with a variety of causes. We’ll explore this a bit more.
3. **Random variation** Sometimes things are busier or quieter than we have expected, with no known explanation. This is often seen as random, natural variation.
4. **Special cause or one-off events** One-off events, planned or unplanned, can cause demand to increase or decrease significantly, usually as a temporary effect.

Activity 6 Patterns of demand

Allow approximately 5 minutes

Which areas of your own demand would you see declining or increasing?

Provide your answer...

Discussion

In policing there are several areas where more demand is expected in the future in general. These include cybercrime and online fraud, with some offences being under-reported, such as domestic violence. In the future it is likely that some of these types of offences will be reported more. There is a trend towards some additional non-crime demand for resources, especially that related to incidents involving mental health. Some crimes, such as burglary have fallen. You may have some very specific local trends in demand that others might not see so much.

7 Understanding seasonality

In this section we look at the idea of demand seasonality. This is where there are cyclical patterns in the demand data. Seasonality can occur over a range of timeframes. For example we will always expect some annual demand seasonality, but many services will see daily or hourly demand cycles they have to manage.

Activity 7 Causes of demand seasonality

Allow approximately 5 minutes

Take a look at the following products. What are the underlying causes of demand seasonality over a year? To what extent will demand change?



Figure 4 Examples of seasonal products

Answer

There are two categories shown in the photos:

Products with weather seasonality

Products such as sun cream, soft drinks and umbrellas have seasonality based around weather. Sales of drinks and sun cream can go up by 500% in a week during a hot spell – but this is not the time people will buy umbrellas! There are other underlying factors – for instance the sun cream sales will also increase at a time when more people start to take summer holidays.

Products with event seasonality

Products such as Easter eggs and Christmas cards clearly have a seasonality based around particular festive events. A problem for those making them is that the sales window for such products can be narrow.

Other seasonal factors

What other seasonal factors exist? Beyond festive events and weather, are there any other causes of fluctuations in demand? Figure 5 below shows some of the underlying causes of demand seasonality.

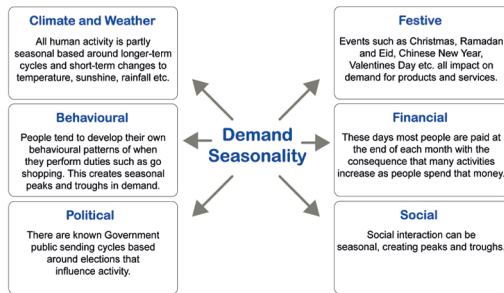


Figure 5 The underlying factors that influence demand seasonality

The next section looks at situations where demand can spike during 'one-off' events.

7.1 Special events

Sometimes we get special 'one-off' events that increase or decrease demand hugely. Sometimes these are planned, such as a music festival. Sometimes these are unplanned or unexpected, such as an industrial fire. Example of special events: Notting Hill carnival



Figure 6 The Notting Hill Carnival

The Notting Hill Carnival in London is regarded to be the second largest carnival in the world, behind the one in Rio de Janeiro, with 1 million people attending over the extended holiday weekend. The carnival has about 40,000 volunteers helping out and usually about 9,000 police.

The carnival creates a huge surge in demand for both private and public services. In a normal year about 270 licensed food, drink and merchandise stalls temporarily appear. The organisers also provide support services, such as an extra 329 sets of temporary toilets. Local transportation has to adapt to be able to accommodate the extra inflow and outflow of people in the Notting Hill area. Local healthcare systems also have to deal with an extra 1,000 casualties needing ambulance or paramedic care, with 20% going to hospital.

Activity 8 Seasonality in your own service

Allow approximately 10 minutes

Now apply these types of demand variation to your own work. Fill in the table below:

Question**Your response**

Are there daily fluctuations in your demand? If so, why?

Provide your answer...

Does day-of-week affect your demand?

Provide your answer...

What annual cycles of demand do you have (if any)?

Provide your answer...

Are there special events that increase your demand?

Provide your answer...

To what extent does your organisation measure or record demand and especially these demand fluctuations?

Provide your answer...

Discussion

We would expect most people to be able to identify examples of demand behaviour in all of the above categories. Anti-social behaviour, for example, tends to happen more when pubs and nightclubs are open but are starting to shut. They will also have an obvious day-of-week effect under most circumstances simply because Friday and Saturday are their busiest days of the week. However, these differences are becoming less noticeable in many cities. Most places will have annual cycles, but not necessarily the same ones. For example, university towns will have demand created by events such as 'Freshers' week'. Seaside towns will experience increases in many types of demand during the summer and other school holidays. You should be able to find special causes such as carnivals, concerts and festivals in many places.

The next section looks at how this understanding of demand patterns can help build a forecast that is used to predict future demand.

8 Forecasting methods

Most situations use one of three types of forecasting model to help predict demand:

- Qualitative techniques can be used when there is no prior data. These would include expert panels or conventional market research, where this is appropriate.
- Time series analysis takes historical data and looks at the patterns in it with the intention of understanding future demand if the same patterns repeat. The analysis can range from the relatively simple approaches of understanding averages ('moving averages'), to much more complex multi-variate techniques and probabilistic analysis.
- Causal analysis can be used to develop more sophisticated demand predictions. Data is used to help understand the factors that drive demand.

For a practical understanding of local demand, simple time series analysis is probably the most appropriate, but strategic planning activities will often use more sophisticated causal models.

We have spent quite a bit of time understanding demand. We will now focus on understanding how we manage capacity to meet demand.

9 Level and chase capacity strategies

When demand patterns are understood a service can decide when and how much capacity to provide to meet that demand. Where demand fluctuates there is the question 'to what extent do we change capacity over time to match demand?' This section looks at the reasoning that addresses this question.

Activity 9 Demand over time

Allow approximately 10 minutes

The figure below shows the expected demand over a period of time, e.g. one year. You can see there is quite a lot of seasonal variation in expected demand.

Coping with Demand Variation

Demand variation occurs in 2 ways:
1. Seasonal fluctuation
2. Random variation

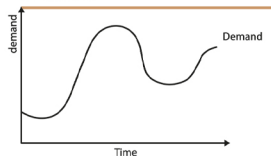


Figure 7 Meeting demand with a 'level' capacity strategy

The figure also shows a potential 'capacity strategy' that provides a constant amount of capacity throughout the year – known as a level capacity strategy. What do you think the likely advantages and disadvantages of this strategy are?

Answer

The level strategy is not good at minimising wasted or idle resource as there are long periods where capacity significantly exceeds demand. A key advantage is that the plan should always meet demand – as long as the demand forecast used is reasonably accurate. Another simple feature is that the plan is quite easy to implement as the people involved in organising resources know that they need to keep the resource plan the same throughout the year.

Now let's look at a different capacity strategy. In this case the capacity is adjusted periodically so that it matches more closely the profile of forecast demand. This is known as a chase strategy. Is this always a better approach?

Coping with Demand Variation

Demand variation occurs in 2 ways:
1. Seasonal fluctuation
2. Random variation

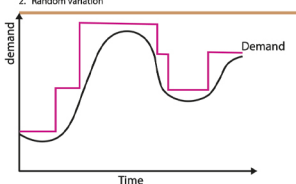


Figure 8 Meeting demand with a 'chase' capacity strategy

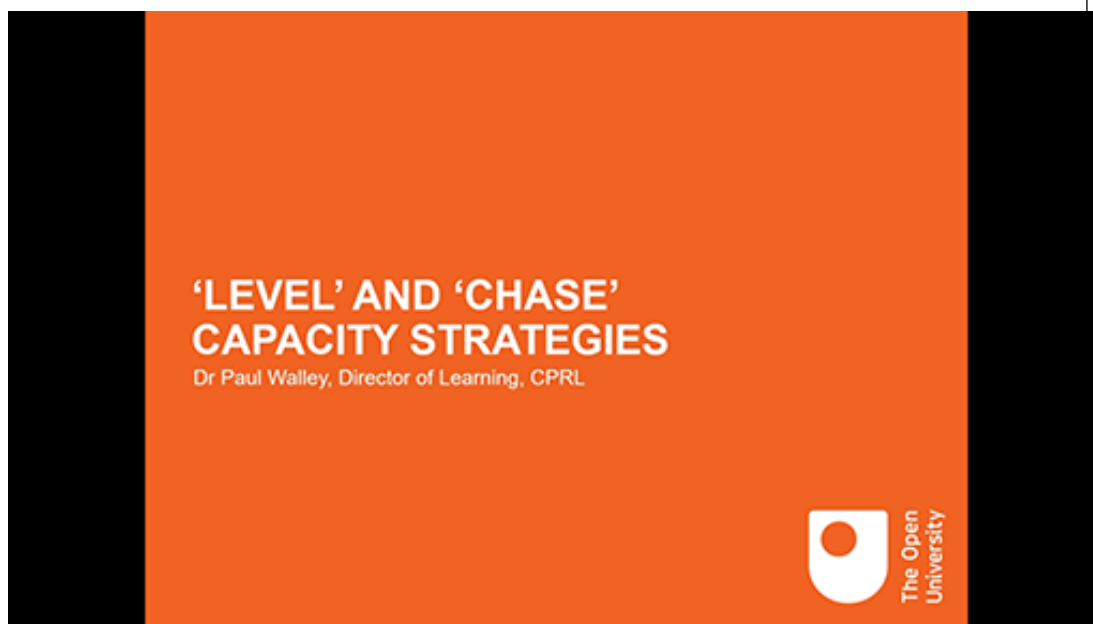
The resources in this case have higher utilisation and you would expect this to be more efficient. However, this is not always the case. The key issue is that changing the capacity can be difficult to implement in some cases – think about how we might do this: Seasonal staff? Different shift patterns? Agency staff?

In some of these cases the extra resource might be more expensive and less productive than those on long-term contracts. Hence we sometimes have to balance between the stability of level strategies and the complexity of chase.

The following screencast explains the theory of level and chase capacity strategies in more detail.

Video content is not available in this format.

Screencast 1: Level and Chase



The next section looks at how you might visualise data such as demand patterns.

10 Visualising your own demand

Sometimes you won't have access to large data sets that will give you a definitive answer about what demand is coming in. However it is worth looking at the data just to gain an impression of what might be happening.

Activity 9 Arrival patterns in A&E

Allow approximately 15 minutes

The table below contains real data of patients arriving at a small emergency department of a hospital, recorded by day of week.

Patients arriving at an emergency department by day

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
86	104	105	75	95	103	96
85	83	82	78	94	91	87
89	102	85	80	99	109	114
105	91	97	90	82	106	107
95	88	90	86	91	76	75

How might you first look at the data? What sort of analysis might you first undertake? Have a think and then click the discussion button below.

Provide your answer...

Discussion

The first action could be to plot the data on a simple chart just to see if there are any apparent trends or patterns that are obvious. We might be looking for any growth or decline trends, but these are unlikely to be seen in such a small data set. There could be cyclical patterns based around day of week but these are not immediately obvious from this graph, so more work can be done there. It is obvious that the data has some random variation.

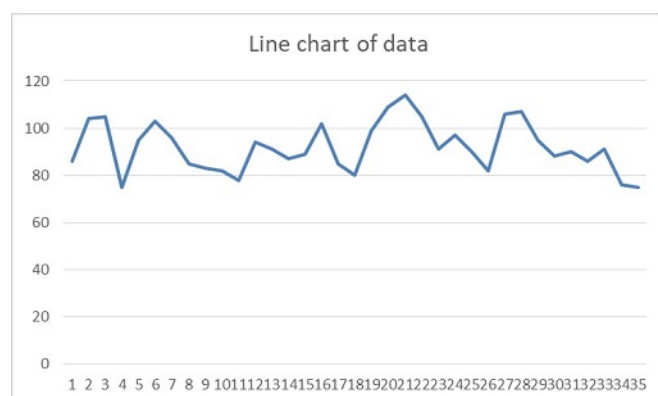


Figure 9 A line chart of the demand data

What day of week effects might be seen? How can you analyse this?

Discussion

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Max	105	104	105	90	99	109	114
Mean	92	93.6	91.8	81.8	92.2	97	95.8
Min	85	83	82	75	82	76	75

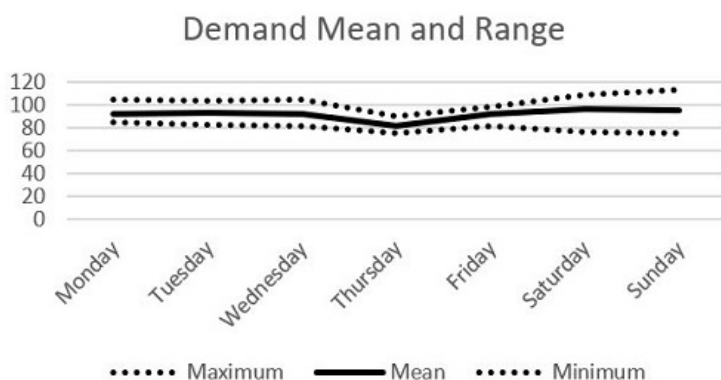


Figure 10 A graph of the demand mean and range by day of week

In this case the data tells us that most weekdays are very similar in terms of the number of people coming into the department for some kind of treatment. A typical day would have around 92 patients to treat over the 24-hour period. Thursday seems to be unusual – but there isn't an obvious explanation. There does appear to be a slight difference at the weekends, which seem to be slightly busier but also the numbers seem to vary more as well. This might need to be explained. Obviously, only a much bigger data set would give us statistically significant results, but at least we now know something about the likely patterns in the data. We'd also need a much bigger data set to look at annual variation etc. (e.g. summer vs winter).

How might this outcome affect capacity planning?

We would need to look at the distribution of arrivals over the 24-hour period to fully understand what to do here. However, if we need to treat every patient how many should we be capable of seeing each day? If we plan for 92 patients per weekday would this be enough?

Discussion

If we only planned for 92 patients per day we would most likely not have enough capacity about half the time. To absolutely guarantee meeting demand we would have to take a look at our busiest ever day. As we have only a small amount of data demand can be even higher, as natural variation and special events would occasionally take it beyond our observed maximums. In practice we would have to also consider having some time of capacity on standby, maybe working other roles but brought in if demand goes higher than expected. In the next section we will also consider how this demand and capacity balance can affect how long people wait in a queue.

We next look at the causes of waits and delays in services, such as how queues form.

11 Why do we have queues?

Just about everyone has experience of being in some sort of queue. If you phone your bank, telecoms provider or similar service you will almost certainly be phoning a call centre where you can often expect to wait before someone picks up the phone. Similarly if you visit a supermarket you can expect to wait before you pay. In a barbers shop you wait your turn. If you go to a theme park many of the rides can have queues that are an hour long on busy days.

So why is it that all of these different types of service make you wait? Are they all just incompetent at managing capacity? Is it they are greedy and won't pay enough staff on duty to meet demand?

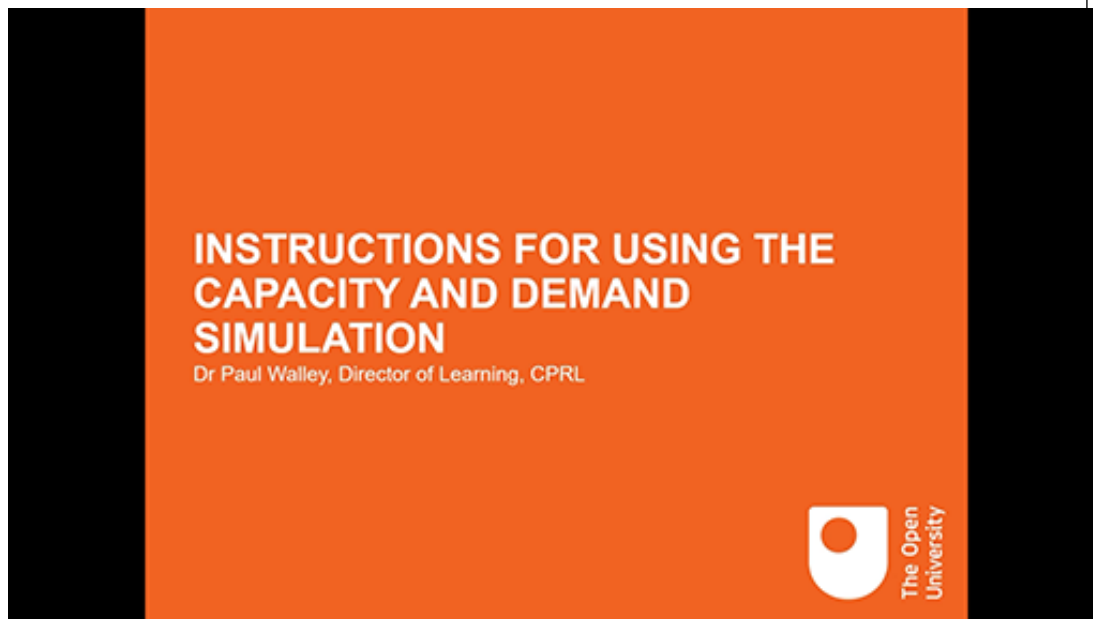
Download the following excel file and open it so you can see the content (open the file in a new tab or window by holding down Ctrl [or Cmd on a Mac] when you click on the link).

[Basic capacity model](#)

Now watch the following screencast that shows you how to use the spreadsheet in the following exercise.

Video content is not available in this format.

Screencast 2: Instructions



Using the average demand of 40 (ranging between 20 and 60) as has been set in the spreadsheet, complete the following tasks:

Task 1 Set your capacity much below average capacity. What happens to the size of the queue? Make a note of this. Repeat this a few times to see if the answer is always the same.

Task 2 Set your capacity at the average demand. Has the queue behaviour changed? Again make a note. Again, repeat this a few times to see if the answer is always the same.

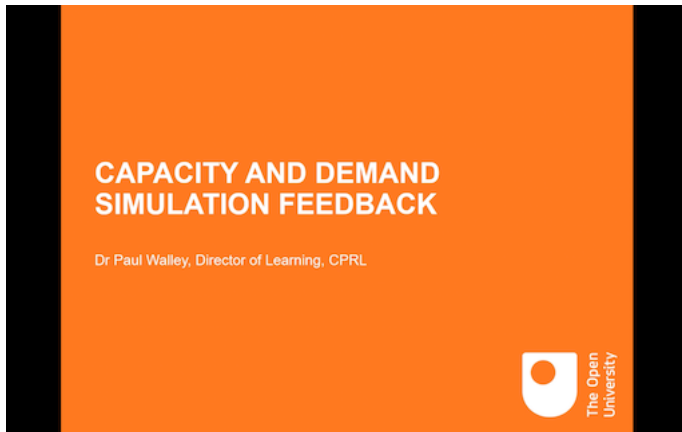
Task 3 Now incrementally increase capacity until you think you have enough. How much capacity makes your queue disappear to almost zero?

Does the existence of a queue provide a clear indication there is not enough capacity to meet demand?

Once you have completed all the tasks watch the following screencast that provides feedback about the findings that you should have got from the exercise. Check that you did get the same kinds of results.

Video content is not available in this format.

Screencast 3: Feedback



The exercise shows that queues can form even when capacity is greater than demand. The following screencast explains the theory underpinning this idea.

Video content is not available in this format.

Screencast 4: What causes a queue?



Waits and delays example: Ambulance service responsiveness

Ambulance services are a good example of where demand must be understood so that planning can take place to ensure enough ambulances are available to meet all emergency demand. In the UK ambulance services are tasked with responding to life-threatening, urgent demand (“Category 1”) with an average response time of seven minutes and 90% within 15 minutes or less. The services have to plan the right number of ambulances and crew each day, anticipating any seasonal fluctuations in demand and taking into account random variation in demand that makes some days unexpectedly busy. As we can see from the previous section, there would need to be some spare capacity in the system if queues are not to develop.

When calls come in they are triaged so that urgent cases are put ahead of those less serious. When ambulances attend calls they will try to deal with the patient without a time-consuming journey to hospital either by treating and discharging those less seriously hurt in situ or by seeking alternative forms of transport to hospital for “walking wounded”. Some services even organise taxis for patients where an ambulance is not strictly necessary.

At busy times for emergency care one of the biggest problems is that ambulances often have to queue to drop patients off at A&E. This means the ambulances become unavailable for new patients and response times increase.



Figure 11 Ambulance queue outside an emergency department

We can see from queue theory that a small reduction in demand might make a big difference to waits and delays. The next section looks at an approach that tries to reduce demand entering a service by eliminating unnecessary demand.

12 Is some demand unnecessary?

Think about the last time you phoned a service provider. Was this for a good reason (e.g. you wanted to buy something) or was it because something had gone wrong? When we analyse calls going into service calls centres we often find that a very large proportion of the calls up to 80% are from unhappy or disgruntled customers reporting a problem rather than customers contacting the service to generate new business. Demand entering the system for avoidable reasons is often referred to as failure demand. One definition is shown below.

'Failure demand is demand caused by a failure to do something or do something right for the customer.'

This idea that much demand is unnecessary or avoidable came from John Seddon when he had looked at calls coming into call centres. He divides demand into two categories 'true demand', i.e. new demand from a customer and 'failure demand'.

Activity 10 Failure demand

Allow approximately 10 minutes

John Seddon and his consultancy team analysed 1200 calls coming into a council housing service call centre (Evaluating Systems Thinking in Housing, 2008). Most callers were council tenants who were dealing with necessary repairs to their properties. The team grouped these calls around main themes, listed below. Use the table to tick whether you see the demand as 'true' demand or 'failure demand'. Count up what percentage of the total you see as failure demand.

Then look at the two columns. What underlying problems are revealed by the nature and levels of failure demand?

Interactive content is not available in this format.



Discussion

Those calls requesting a service for the first time, such as 'I need a plumber', are all true demand. The failure demand calls are made when something has either gone wrong, e.g. 'the repair was not fixed properly', or the work is being chased by the customer, e.g. 'I'm still waiting for...'.

The chart below shows that 80% of the calls coming into the system were failure demand and the most common types of call were all failure demand.

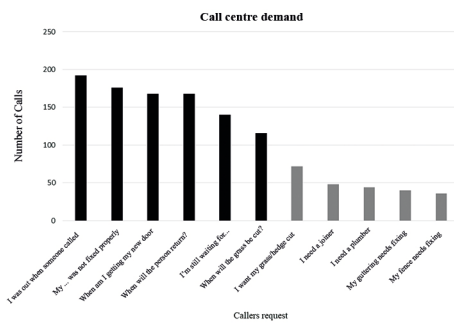


Figure 12 Call centre demand chart

There is clearly a problem within the housing service because too many work crews are attending properties when the customer is not present. They also seem to have difficulty finishing a job in one visit (shortage of spare parts?), or returning to finish a job in a timely manner (scheduling?). When the problem was studied in more depth it became clear that work crews were not empowered to deal flexibly with their customers' problems because the cost control systems limited the availability of spares, required too many sign-offs before work was completed, and was too rigid in its scheduling of crews. Once crews were given more control over their work they were able to call customers in advance and ask about the need for spare parts etc., with deliveries to site quickly. This produced a huge improvement in the quality of the service to the customer and reduced demand.

This next exercise allows us to explore the notion of failure demand in a practical exercise. Use this as an opportunity to see whether or not you can spot unnecessary demand in a system.

Activity 11 Failure demand

Have a think about how much of the work coming in to your system might be classed as failure demand. What are the underlying causes of that demand? Also think about the impact on your work and whether or not the demand can be removed.

Provide your answer...

Discussion

One of the biggest, somewhat hidden, sources of failure demand can be seen just by looking in your email inbox. Have a look to see how many emails are repeat requests, such as reminders for deadlines. How many of the emails are you copied in when it's irrelevant to you?

For much of the demand coming in, have a look to see if there are more opportunities to do the work in the first contact, rather than prioritising or postponing work. One police force found that 100 non-urgent calls into the contact centre generated about 60 unnecessary additional contacts, with some calls needing 5 or more attempts to do simple things like answer a question.

This session concludes all the topics of *Capacity and demand management*. Now read the course conclusion on the next page.

13 Conclusion

Good decision-making requires effective data analysis when making challenging decisions such as the allocation and timing of capacity. When you look at your own data you will start to see some clear patterns in demand for the services you provide, but sometimes it can be difficult to find enough data. In these situations it is perfectly acceptable to use simple visual tools that give some insight into how demand behaves. The course should have given you a better insight into some operational problems such as response delays or queues in services. When data is collected you can bust the myth that queues only form when systems are under-capacity. The data analysis provides a better insight into why these delays occur.

Our final concept we looked at was that of unnecessary or 'failure' demand. This can be a really useful idea to challenge what demand is coming into a service and what workload it should give you. You are encouraged to try to apply this idea further in your own work.

This course was produced by The Open University in association with the Police Service of Northern Ireland. You can find out more on courses from this series on the [Community engagement and policing](#) page.

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Further reading:

[Visualizations That Really Work](#)

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