Operations Research?

Have you ever been stuck in a traffic jam and wondered if there could be a way to manage traffic better?

Or have you wondered about how a supermarket stocks the right amount of fresh food?

Or perhaps you have been curious about how trains or planes are timetabled to avoid conflicts but meet demand?

The answer to all these questions, and more, lies within Operations Research.

What is Operations Research?

Operations Research is a field that uses mathematical tools to solve real world problems.

In practice these problems often involve large amounts of data and so operations researchers make use of a computer to help them solve the problem.

Operations Research is also known by other names such as Management Science or Business Analytics.

Who are Operations Researchers?

An operations researcher can be anyone!

Indeed; if you have ever arranged your shopping list so that you save time when shopping, or if you have ever bought items to minimise the cost of your bill; then you have acted like an operations researcher!

In practice, however, operations researchers are multi-skilled individuals who use their mathematical, statistical or computer-based knowledge to solve problems.
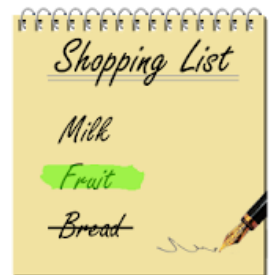
How is Operations Research Used?

Once a researcher has solved a problem, the results can be applied to a business or a government plan to create a better strategy that improves results.

For a business, this could mean an unprofitable product is no longer sold, or that a change to the way ordering is carried out is made. Often the goal will be to enhance profit, however other goals such as reducing waste or improving employee morale could be considered.

Research for a Government may well be the same: focussed on reducing costs, or improving the benefit of a service. An example of this could be reducing A&E wait times.

Where else is Operations Research Used?

A wide range of sectors use operations research. Examples include:

Using Operations Research to better timetable transport to ease congestion or meet demand.

Planning the placement of renewable energy sources to maximise energy production.

Organising the coverage of a sports event to maximise enjoyment for spectators.

The Future of Operations Research

Increasingly businesses and governments are faced with problems that feature large volumes of data.

Operations Research is a field that allows for this data to be analysed, conclusions to be drawn and for a plan of action to be made based on the results.

In this data driven age, then, it seems that operations research will continue to perform a vital role for decision makers both now and in the future.

The first example of Operations Research that is explored further is in the field of transportation. Specifically, the use of mathematical techniques to ease congestion on motorways in the United Kingdom. In order to do this, researchers first constructed a model that simulated the behaviour of cars on a motorway. This model was created using data that the researchers gathered, with a substantial part of this data being taken from GPS data on mobile phones, and the remainder from traffic camera observations. The researchers will have also taken note of the volume of traffic given the time of day, or the day of the week, so that the model can reflect different periods of demand.

Once the behaviour was built into the model the operations researchers were then able to assess why queues built given certain traffic conditions. To do this, they used mathematics related to probability, and in particular queueing theory. Once they were able to understand why queues happened, they were then able to change the conditions of the model to explore how the probability of a queue could be reduced in certain circumstances. In this example, the researchers were able to deduce that if the speed of the traffic could be controlled, the flow of the traffic could be smoothed. The reason for this was because the researchers observed that often a queue formed because a car would brake, and then the car behind would brake slightly more, and then this would translate into traffic slowing significantly further behind. By controlling the speed of the traffic, the researchers were able to demonstrate how fewer queues would occur and that, despite the speed restriction, motorists would have a greater average speed than on an unmonitored motorway.

Today, this has been implemented under the name of a 'Smart Motorway' and features arches at regular intervals which dictate the maximum speed traffic is allowed to travel at, and this is enforced through the use of speed cameras. These motorways have been proven to significantly reduce congestion in several areas, and the plan is to convert multiple existing motorways into smart motorways over the next ten years.

Operations Research is also used in the organising of sporting events. One such example in particular is the use of Operations Research techniques to organise the Olympics in Tokyo in 2020. This event requires the application of several techniques coming from fields including Scheduling, Queueing Theory and mathematical programming.

Already discussed above is how queueing theory can be used to ease congestion on a motorway and here the use of the theory is to ease the flow of spectators into, and out of, a stadium. It also ensures this flow is both smooth and safe. Based on the modelling of spectator behaviour, given the number of people expected to attend an event, operations researchers have been able to recommend both modifications to existing stadia and also designs for the stadia that are yet to be built.

When building the new venues, and also when planning the number of employees required for the games, it is necessary to minimise the cost so that the Olympics do not spend more than their allotted budget. In order to ensure this, Operations Researchers utilise mathematical programming. This is a field that seeks to either maximise or minimise a value – in this instance the cost of hosting the games is minimised – given specific constraints, or requirements, that must also be fulfilled. As a specific example, this could be creating the cheapest stadium that is able to host all the planned events and hold the necessary number of spectators.

In order to decide, however, which events a stadium will host Operations Research must first be used to create a working schedule for the games. Indeed, using mathematical tools the planners of Tokyo 2020 have been able to timetable all the events that will be taking place, reduce the number of events that clash, and also ensure that these events can take place in a suitable location. Furthermore, these scheduling techniques will be used by broadcasters to ensure that audiences around the world can view the greatest number of events possible.

As a result of this information it is clear that Operations Research is vital to organising large scale sporting events like the Olympics and, as the size of these occasions grows, the field will be called upon increasingly in the future when planning other such large scale projects.

Bibliography

All pictures have been sourced from Wikipedia.

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