University of BRISTOL
Business School

# EFIMM0142: Modelling Analytics

## Week 1 (Part a): Introduction to Linear Optimisation

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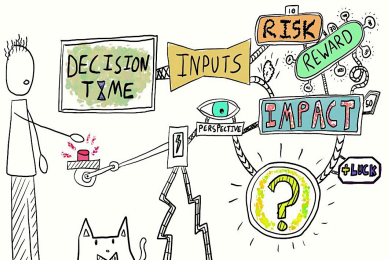
# Learning Objectives

***By the end of this lecture, you should be able to:***

- explain what management science is;
- detail areas in business where management science is commonly used;
- describe the management science - modelling approach.

# Decisions! Decisions!




Managers' responsibility:

To make strategic, tactical, or operational decisions.

- **Strategic decisions**:
  Involve higher-level issues concerned with the overall direction of the organization.
  Define the organization's overall goals and aspirations for the future.

- **Tactical decisions**:
  Concern how the organization should achieve the goals and objectives set by its strategy.
  Are usually the responsibility of midlevel management.

- **Operational decisions**:
  Affect how the firm is run from day to day.
  Are the domain of operations managers, who are the closest to the customer.

# Making Better Decisions


- Management Science (MS) is an approach to decision making based on the **scientific** method, makes extensive use of **quantitative methods**. *(by Anderson, Sweeney, Williams)*

- Management Science is a discipline that attempts to **aid managerial decision making** by applying a scientific approach to managerial problems that involve **quantitative methods**. *(by Hillier and Hillier)*

- Management Science is the application of a scientific approach to solving management problems in order to help managers **make better decisions**. *(by Taylor)*

**Management science models** become useful when common sense and intuition fail to solve the problems.

# Does Management Science Work?

- **BT** used MS approaches to plan to the work of its repair engineers, saving £125 million a year.
- **British Airways** used MS to review its spare parts policy for its aircraft fleet, saving £21 million a year.
- A **UK hospital** used MS to develop a computerized appointment system that cut patient waiting time by 50%.
- **Ford** used MS to optimize the way it designs and tests new vehicle prototypes, saving over £150 million.
- **Samsung** used MS to cut time taken to produce microchips increasing sales revenue by around £500 million.

# Management Science Applications

- Assignment
- Data mining
- Logistics
- Marketing
- Financial Decision Making
- Optimisation
- Transportation
- …….

# Modelling VS Models

- This unit stresses **modelling**, not models.
- Learning specific **models** is essentially a memorization process.
- **Modelling** is a process where you abstract the essence of a real problem into a model.
- **Successful modelers** treat each problem on its own merits and model it appropriately, using all the logical, analytical, and spreadsheet skills they have.

# The 7-Step Modelling Process (I)


Step 1: **Problem Definition**

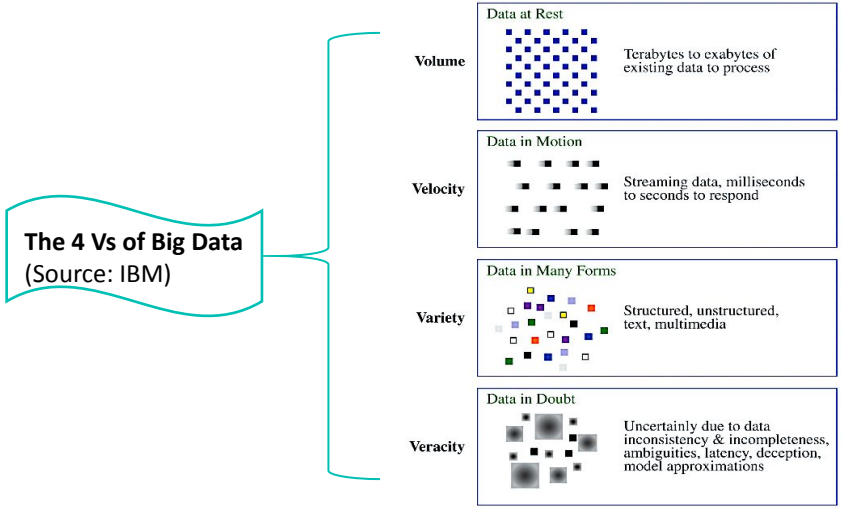
- Typically, a management science model is initiated when an organization believes it has a **problem** and calls in the analyst to **solve** it.
- In such cases, the problem has probably already been **defined** by the client, and the client hires the analyst to solve this problem.
- The task of the analyst is to do some **investigation** before accepting the client's claim that the problem has been properly defined.

**Defining the problem** includes specifying the **organization's objectives** and the parts of the organization that must be studied before the problem can be solved.

# The 7-Step Modelling Process (II)

Step 2: **Data Collection**

- After defining the problem, the analyst collects data to estimate the **value of parameters** that affect the organization's problem.
- All organizations keep track of various data on their operations, but the data are often **not** in the form the analyst requires.
- One of the analyst's first jobs is to gather exactly the **right data** and put the data into an **appropriate** and **consistent format** for use in the model.



# The 7-Step Modelling Process (III)

Step 3: **Model Development**

- After defining the client's problem and gathering the necessary data, the analyst must develop a model of the problem.
- Models are representations of real objects or situations
- Three forms of models are:
  - ✔ **Iconic models** - physical replicas of real objects
  - ✔ **Analog models** - physical in form, but do not physically resemble the object being modeled
  - ✔ **Mathematical models** - represent real world problems through a system of mathematical formulas and expressions based on key assumptions, estimates, or statistical analyses (e.g., deterministic optimization models, simulation models)

# The 7-Step Modelling Process (IV)

Step 3: **Model Development** (cont.)

Several properties are desirable for a **good model**.

- It should represent the client's real problem **accurately**.
- If the model ignores an important constraint, such as an upper bound on capacity, its recommendations might not be possible to **implement**.
- If a model ignores uncertainty when uncertainty is a key aspect of the problem, its findings won't be very **believable**.
- A good model should achieve the **right balance** between being too simple and too complex.

# The 7-Step Modelling Process (V)

Step 4: **Model Verification**

- The analyst now tries to determine whether the model developed in the previous step is an **accurate representation** of reality.
- The model must pass "***plausibility checks***". In this case, various input values and decision variable values are entered into the model to see whether the resulting outputs are plausible.
- If the model's outputs are **not** as expected, then the model is a poor approximation of the actual situation, or the model is fine, but the analyst's intuition is faulty.

# The 7-Step Modelling Process (VI)

Step 5: **Optimisation & Decision Making**


- To use the model to recommend decisions or strategies, the model has to **optimize an objective**, such as maximize profit or minimize cost.
- The **optimization** phase is typically the most **difficult phase** from a mathematical standpoint.
- Several **solution algorithms** are available to solve real problems (e.g., simplex algorithm, branch-and-bound).
- When the problem is too complex, a **heuristic** is used to solve it. Heuristic is guided by common sense, intuition, and trial-and-error.

# The 7-Step Modelling Process (VII)

Step 6: **Model Communication to Management**

- The analyst must eventually **communicate** a model and its **recommendations** to the client.
- A large gap typically exists between management science analysts and the managers of organizations. Managers know their business, but they often do not understand much about mathematical models.
- The best strategy for a successful presentation is to **involve key people** in the organization, including top executives, **in** the **project from** the **beginning**.
- The analyst should also try to make the model as **intuitive** and **user-friendly** as possible.

# The 7-Step Modelling Process (VIII)

Step 7: **Model Implementation**

- If the organization has accepted the **validity** and **usefulness** of the study, the analyst then helps to implement its recommendations.
- The implemented system must be monitored **constantly** (and updated **dynamically** as the environment changes) to ensure that the model enables the organization to **meet its objectives**.
- A useful model, once implemented, is likely to be **expanded** by the organization.