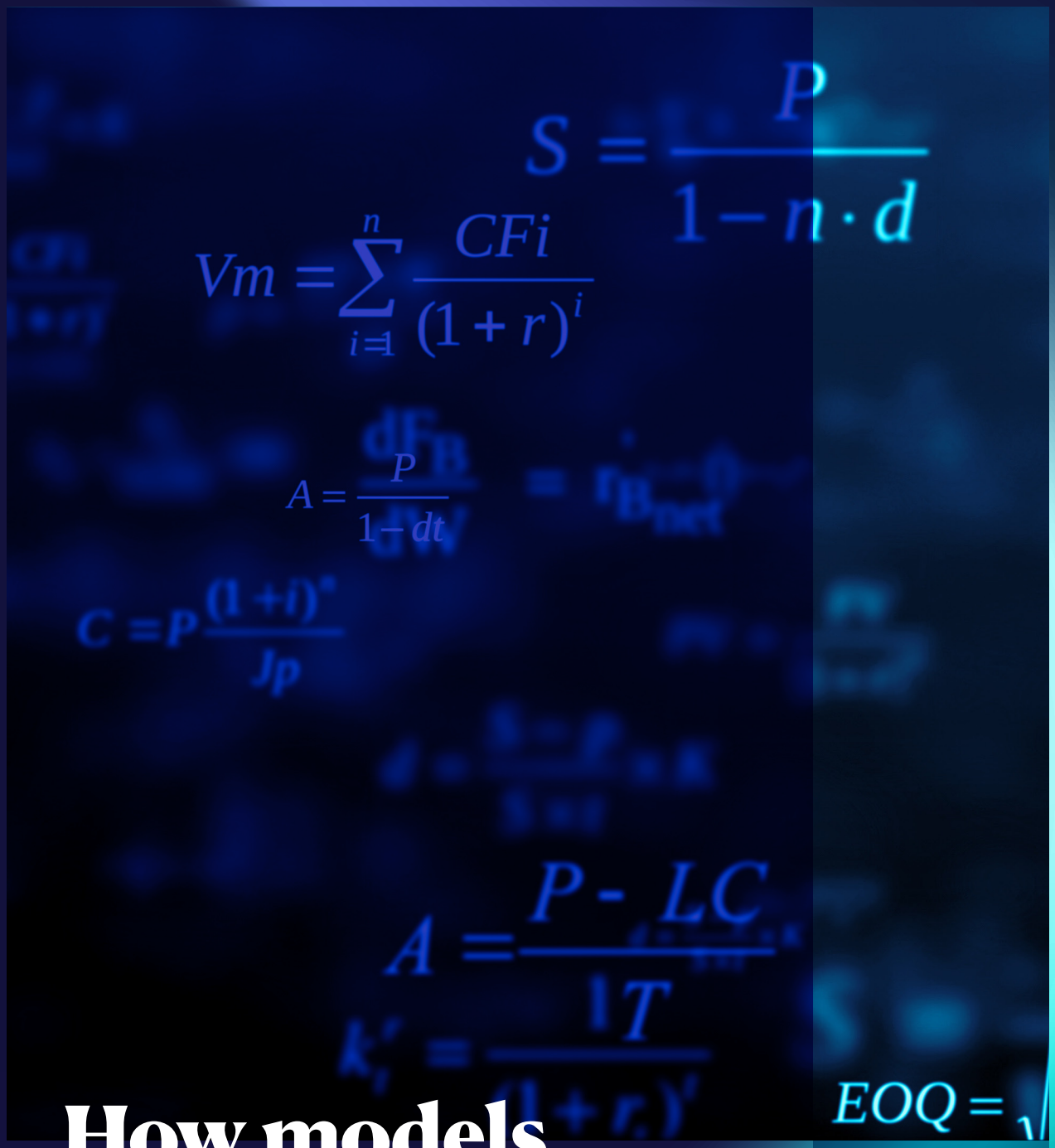
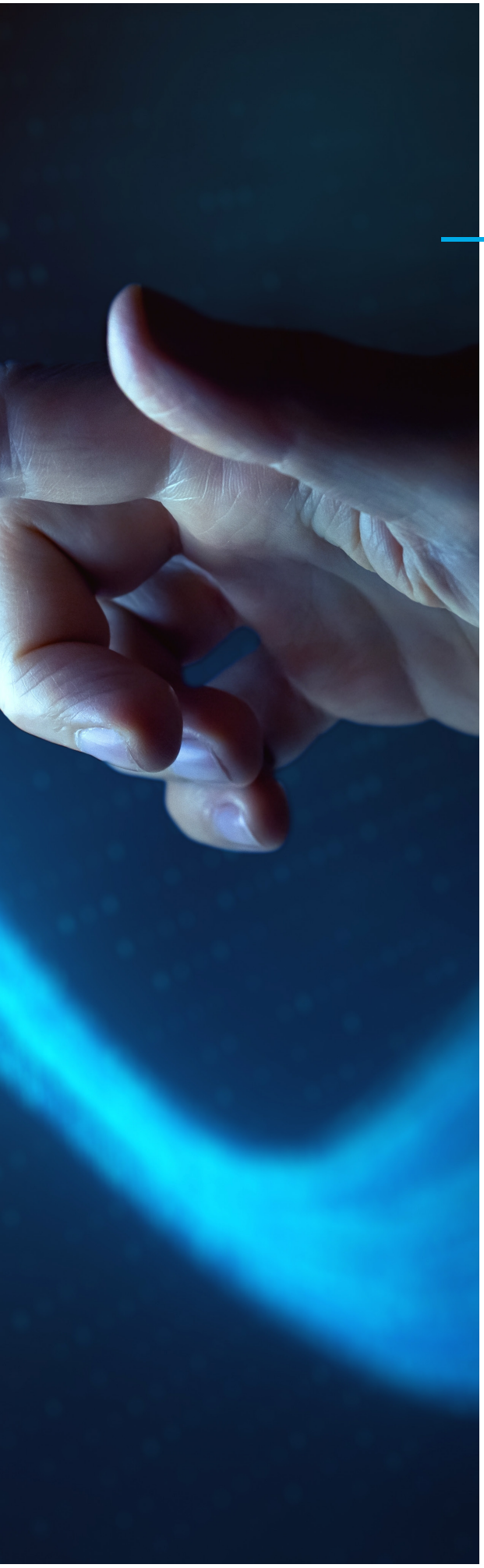
OCP SOLUTIONS



How models can help you make better decisions?

June 2023



Introduction

For nearly three years, the world have been living through an unwelcome crisis that most of us did not expect, despite warnings that were largely ignored [1].

The Covid-19 pandemic hit fast, nearly half of the world population was locked in their homes causing severe economic turmoil and sending chaos shockwaves across global supply chains. This has underlined once again an already ongoing trend of our globalized world: more VUCA (Volatility, Uncertainty, Complexity, and Ambiguity).

For decades, companies and governmental institutions have been using decision tools based on mathematical models and AI to optimize their operations and make informed decisions. During the covid-19 pandemic, those models have proved even more useful in planning response strategies and in navigating brutal disruptions of global supply chains. The most notable example was the wide use of analytics and mathematical models by public health decision-makers to make informed decisions about deploying mass clinical tests and planning vaccines delivery [2].

What is a model?

We call a model any quantitative method, system, or approach that uses mathematical theories, assumptions, to process data into quantitative estimates.

Think of your Excel spreadsheet that estimates your company's cash flows forecasts of next year? Well that is also a model!

Models can be:

Descriptive	Promote understanding of complex behaviours of real objects or systems. Ex. A chemical plant capacity utilization dashboard.
Predictive	Analyse historical and current data to help predict future outcomes. Ex. forecast fertilizers demand in Brazil in next three months.
Prescriptive	Support decision-making by analysing business operations and strategies, informing business decisions, identifying and measuring risk. Ex. Autonomous cars.

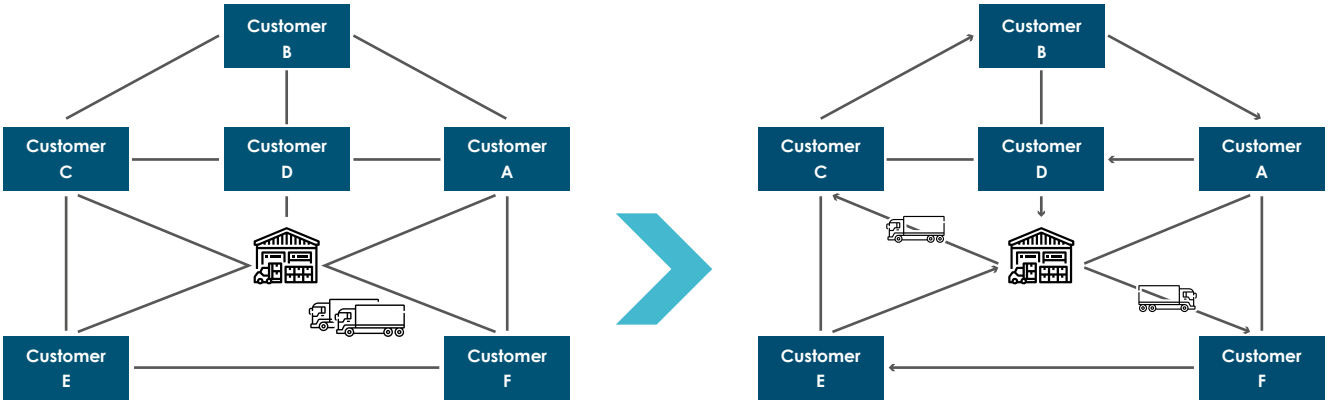
Models can help you:

- Promote understanding of complex business problems within your organization by simulating a "digital twin"[1] of your business problem that takes into account your own business processes.

- Improve your decision making journey by taking the best decision possible through the use of a rational, fact based framework rather than relying on intuition only.

- Identify and quantify risks by measuring their probabilities of occurrence as well as their costs and consequences.

- Establish a shared vision within your organization by stating targets and objectives to achieve and stating the constraints (soft and hard).



The vehicule routing problem (VRP): how to deliver clients today from your warehouse while reducing your transport costs.

Distance (km)	A	B	C	D	E	F
A	0	100	●	80	●	150
B	100	0	120	20	●	●
C	●	120	0	70	140	●
D	80	20	70	0	●	●
E	●	●	140	●	0	300
F	150	●	●	●	300	0

The facility location problem (FLP): What are the best locations for covid-19 vaccination centers in Casablanca to maximise the number of vaccinated population? [1].

We identify two main categories of models used in solving business problems:

- Operations Research
- Artificial intelligence

[1] A digital twin is a virtual replica of a real-world physical system or process (ex. a container port, factory ...)

What is Operations Research?

Operational Research (O.R.) can be described as the discipline of applying analytical methods to help make better decisions. It is a discipline with a strong real world focus and aims at improving the complex systems and processes that underpin our daily life.

O.R relies heavily on mathematical optimization and is used widely in the business world to optimize high-cost, high-risk operations such as manufacturing plants and supply chains management where inefficiencies can cost tens of thousands of dollars per hour.

Some examples of Operations Research applications:

- If your company have to deliver 1 billion Covid-19 vaccines doses around the world. How can you do it in the shortest amount of time and costs? (DHL)
- Given all your clients demands this month (300+ clients in 5 continents, millions of tons of fertilizers and more than 10 types), what is your optimal production plan across your mines and chemical plants to maximize your profits given your supply chain and logistical constraints? (OCP)
- An airport hub shuts down due to a storm — all flights are cancelled. Rearrange the flights of all planes in your airline to get as many passengers as possible to their destinations. (Continental Airlines)
- Schedule all baseball games for a season. Flying teams around costs thousands of dollars per hour, so make the schedule that minimizes the cost spent on travel. (MLB games)

Since its early beginnings in World War II, O.R. focused on supporting decision making in a wide range of organisations. It is a major contributor to the development of decision analytics, which has come to prominence recently thanks to the explosion of big data. Today, O.R. use continues with different labels such as business analysis, decision analysis, analytics or management science.
To summarize, O.R. is the art of : better , faster, applicable :

Better

Lower costs, higher revenues, higher productivity, lower emissions,...

Faster

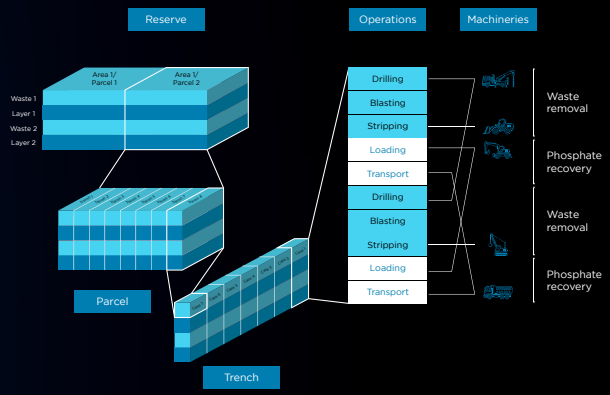
Complex manual operations taking minutes instead of hours and days

Applicable

End user perspective is taken into account

Example of a Phosphate mine machineries operations planning models using Operations Research methods (Mixed Integer Linear Programming)

Problem



How to plan mine machinery circuits to meet production targets and reduce cost ?

Model

$$\min_{x,y} \quad c^T x + d^T y$$

$$\text{s.t.} \quad Ax \leq b$$

$$Ey \leq f$$

$$A \in \mathbb{R}^{m \times n}, E \in \mathbb{R}^{p \times q}$$

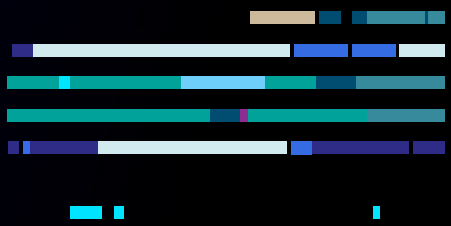
$$b \in \mathbb{R}^m, f \in \mathbb{R}^p, c \in \mathbb{R}^n, d \in \mathbb{R}^q$$

$$x \in \mathbb{Z}^n, y \in \mathbb{R}^q$$

$$\begin{aligned} \text{maximize} \quad & c^T x \\ \text{subject to} \quad & Ax + \mathrm{s} = \mathrm{b}, \\ & \mathrm{s} \geq 0, \\ & \mathrm{x} \geq 0, \\ \text{and} \quad & x \in \mathbb{Z}^n, \end{aligned}$$

Mixed Integer Linear Program (MILP) problem formulation

Solution



Mine Machineries GANTT schedule

What is Artificial Intelligence (AI)?

Artificial Intelligence is the theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception and speech recognition.
AI can be found today all around us as it offers countless services that mankind has become dependent on.

Here are some example of AI use:

- Digital personal assistant (Amazon Alexa)
- Autonomous driving (Tesla)
- Facial recognition (Facebook)
- Targeted online ads (Google)
- Recommendation systems (Netflix)
- Predictive maintenance of machineries (BASF)

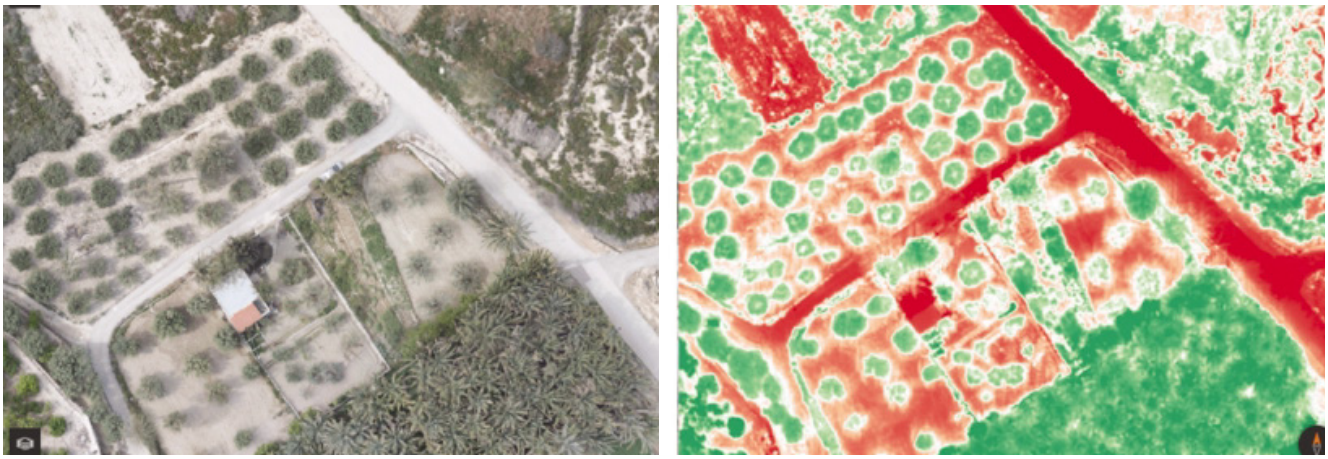
AI came into prominence in industry and media in recent years thanks to the combination of the following factors:

- Explosion of data and business models directly dependent on client behaviour forecasting (Google, Amazon, Facebook...)
- Big Data and Cloud has allowed a separation of storage and computation powers which propelled high intensity algorithms capability (think of AWS)
- Open Source has empowered hundreds of thousand AI researchers and engineers all over the globe collaborating together (Python, Github, ...)
- Technological breakthrough in algorithms (face recognition, ...)

It is important to demystify a few buzzwords when it comes to AI:

Big Data	***extremely large data sets*** *that may be analysed computationally to reveal patterns, trends, and associations*
Artificial Intelligence	*the theory and development of* ***computer systems*** *able to perform* ***tasks normally requiring human intelligence,*** *such as visual perception, speech recognition, decision-making...*
Machine learning	*the use and development of* ***computer systems*** *that are able to* ***learn and adapt*** *without following explicit instructions, by using* ***algorithms*** *and* ***statistical*** *models*
Deep learning	*a type of* ***machine learning*** *based on* ***artificial neural networks*** *in which multiple layers of processing are used to extract progressively higher level features from data*
Data Analytics	*the process of* ***examining raw datasets*** *to draw* ***conclusions*** *and* ***insights*** *about the information they contain.*

AI algorithms accuracy rely heavily on large amounts of historical data used for training and validation. AI solutions are thus called “data-driven” in opposition to O.R that is considered “system-driven” where one needs to describe complex systems with mathematical equations but not necessarily need large amounts of historical data.
The United Nations (UN) is combining on-ground sensor and drone data to fine-tune their Machine Learning algorithms to improve pest management.



Source : PwC Commercial drone consulting project

Food & Agriculture Organization of the United Nations; E-agriculture in action: drones for agriculture, Bangkok, 2018

Takeaways

Today’s business problems are too complex to rely on intuition and instinct alone.

Top performing companies use models to create a competitive advantage for their businesses and make better decisions every day, their usage of those models is only increasing.

Using models can help you:

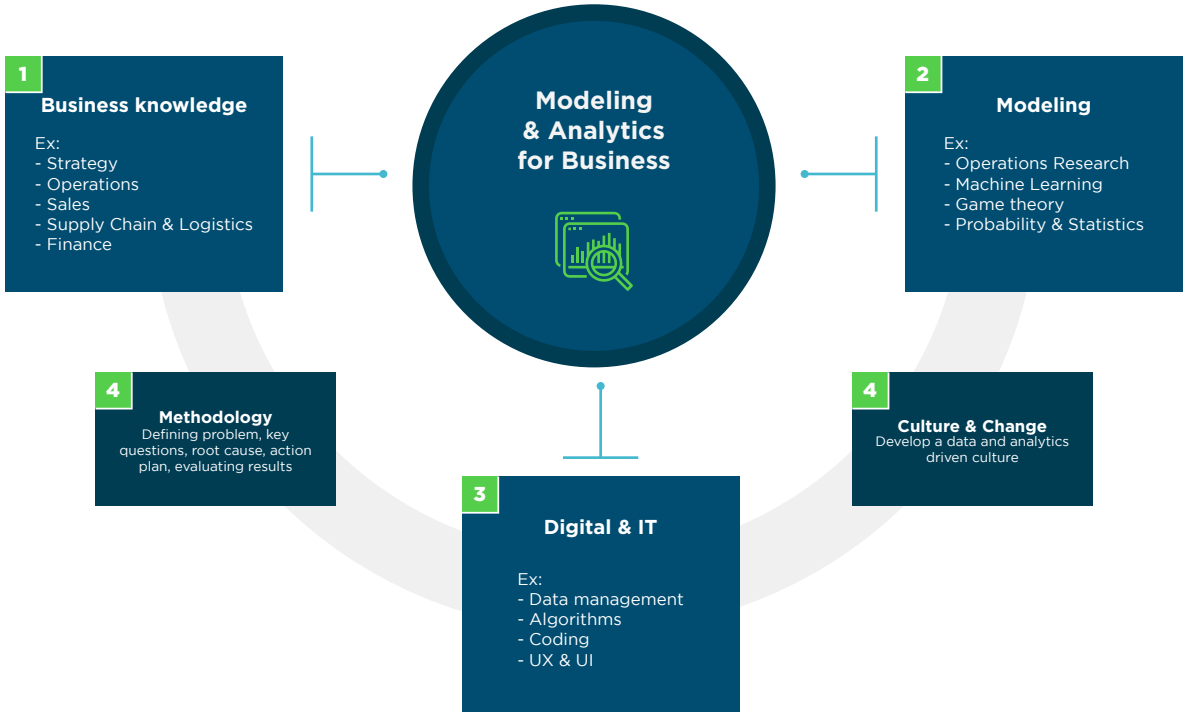
- Enhance your decision making journey by taking the best decision possible through the use of a rational, evidence based framework
- Establish a shared vision within your organization by stating clear targets and objectives to achieve and stating the constraints (soft and hard)
- Identify and quantify risks by measuring their probabilities of occurrence as well as their costs and consequences
- Promote understanding of complex business problems within your organization by simulating a “digital twin” of your business problem that takes into account your own business processes
- Encapsulate your teams knowledge and know how into algorithms that can be used across your organisation
- Drive change within your organisation by adopting key KPIs that the model describes or predicts

Implementing models is not about hard science only more of a thoughtful combination of several disciplines: business specific knowledge, mathematics, digital & IT, processes and change management

What we do at OCP SOLUTIONS? Modelling in the new world

At OCP SOLUTIONS, we believe that your business problems are too complex to rely on intuition alone. According to Forbes, **85 pc of Fortune 500 companies** use mathematical optimization in their operations.

However, being top notch in the mathematical and technical disciplines is not enough to ensure successful models implementation in practice. Our conviction is that a successful model implementation should follow a holistic framework based on five key pillars: Business Knowledge, Modelling, Methodology, Culture & Change, and Digital & IT.



Source : OCP SOLUTIONS

About the authors

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He has acquired during 19 years rich and varied experiences in the financial sector, particularly in quantitative modeling, advanced analytics, investment banking, commodities, supply chain and risk Management and financial markets. He was formerly head of Quantitative Team at Natixis for commodities and portfolio Management.
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Prior to joining OCP SOLUTIONS, Mehdi spent 12 years in fixed income and commodities derivatives pricing and risk management most recently as a Senior Quantitative Analyst at Bank of America Merrill Lynch in London within its Model Risk Management group.
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About OCP SOLUTIONS

OCP SOLUTIONS is a consulting firm that offers solutions around Analytics, Digital and Strategy.
It was founded to serve OCP, Moroccan, African and international companies.
The firm offers solutions in Quantitative Modeling & Data Analytics to solve complex business problems in various areas (mining, chemicals, logistics, sales, etc.) using state of the art Analytics and mathematical models as well as a solid business knowledge. It delivers also solutions in Digital Transformation by using digital technology to create/improve processes, business models and user experience. The firm delivers solutions in Strategy, Business Transformation & Innovation by defining and selecting value-creating solutions that combine innovation and benchmark.
With a multidisciplinary team, OCP SOLUTIONS associates experienced consultants coming from several horizons to provide clients a whole satisfaction in the management of their projects.

The views expressed in this publication are those of the authors.

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