Operational Research As Key Management Instrument

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Abstract: *When coming about making decisions, individuals endeavour to correctly address issues and to choose the optimum variant among the available ones. Often, the decisional process is made based on the decision-maker philosophy, intuition and/or experience. Depending on the rapidity with which the decision should be made, and on the style of the one adopting it, such process might involve one or many individuals, the latter laying the grounds, via the miscellaneous ideas considered, in providing better results. But in any circumstances, especially in cases where we talk about managerial decisions, if the scientific approach is not effectively involved in the decisional process, the outcomes are less likely to be the most desirable ones. Operational research proves to represent, in these circumstances, one of the key instruments in supporting efficient decision-making, it providing the entitled entities with a series of analytical methods and techniques, such as those related to mathematical optimisation, simulations, neural network, game theory and many others, all of them extremely useful for efficiently achieving the established goals.*

Keywords: operational research, management science, decision-making instrument, analytical methods, optimisation

JEL Classification: C18, C44, D81

1. Introduction

The decisional processes, encountered in our daily activity at any step, are very important for us, people, as the arising decisions are in the position of either improving our life, or, on the contrary, making it worse. This is the reason why we should carefully consider the decisional variants, filtering the same based on specific criteria, in order to identify any possible consequences, and choose the optimum one, the best of them for us, given our expectations.

Obviously, when going forward and discussing in terms of decisions made by us and affecting not only our life and activity, but also the life and activity of others, things dramatically change. And we do not talk about decisions affecting the members of a family or of a group of friends, but about the ones related to a number, more or less large, of employees, in their position of subordinates, expecting for their manager to decide the best for the interest of the organisation to which they belong, finally reflected in their own well-being.

Making decisions with serious impact on other individuals and entities involves a high level of responsibility, therefore forcing the decision-maker to seriously substantiate his/her decisions so as to lay the premises for positive outcomes for all parties concerned.

Scientifically basing the decisions to make becomes, in this context, the best possible approach, as, beside other elements, important as well in a decisional process, such as experience-based aspects, intuition or flair, science helps us in establishing a more precise pattern related to the real evolution of facts and events.

A key instrument reflecting the transposition of science into the decision-making process is represented by the operational research, which encompasses a large range of analytical methods and techniques, including, among many others, mathematical optimisation, simulations, neural network or game theory, elements to be seriously considered in order to lay the grounds for making timely and efficient decisions.

These issues, just mentioned within the present Introduction, are approached, in terms of Literature review, in section 2, are selectively analysed, from the perspective of the related Research methodology, in section 3, and are further construed, via Results and discussions, in section 4. The paper ends with Conclusions, in section 5, reflecting general pieces of information emerging from this study.

2. Literature review

In order to better understand what the above-mentioned management instrument - operational research - is about, we are going to render hereafter several definitions assigned to it.

According to Whatis.techtarget.com, operational research represents "an analytical method of problem-solving and decision-making that is useful in the management of organisations". The problems approached via such instrument "are broken down into basic components and then solved in defined steps by mathematical analysis".

Scienceofbetter.org sees operational research as "the discipline of applying advanced analytical methods to help make better decisions". By resorting to the use of specific "techniques such as mathematical modelling to analyze complex situations", operational research provides the entities

in charge with "the power to make more effective decisions and build more productive systems".

In the vision of bitiritannica.com, operational research is nothing else but the "application of scientific methods to the management and administration of organized military, governmental, commercial, and industrial processes".

A more complex definition is provided to us by the Business Dictionary, operational research reflecting the "application of mathematical (quantitative techniques) to decision-making". In operational research "the problem is first clearly defined and represented (modelled), as a set of mathematical equations". Subsequently, it is "subject to rigorous computer analysis to yield a solution (or a better solution) which is tested and retested against real-life situations until an optimum solution is found."

Decisionanalyst.com considers that operational research "is about deriving optimal solutions to maximize sales or profit and/or to minimize costs, losses or risks". It "refers to scientific methods (statistical and mathematical modelling) applied to the solution of complex business problems".

Given that the operational research is also known as the management science, the definition was also reached for in a mathematical-based environment. Thus, based on the considerations of Wolfram MathWorld, operational research "is a vast branch of mathematics which encompasses many diverse areas of minimization and optimization". Mainly related to this latter concept, operational research "has great many applications, for instance, in agricultural planning, biotechnology, data analysis, distribution of goods and resources, emergency and rescue operations, engineering systems design, environmental management, financial planning, health care management, inventory control, manpower and resource allocation, manufacturing of goods, military operations, production process control, risk management, sequencing and scheduling of tasks, telecommunications, and traffic control".

The list of definitions anyone might encounter is extremely varied, being more or less comprehensive, but all of them converge towards the same idea. We talk about a scientifically based instrument, where rationality is used to the detriment of other intuition based tools, where mathematics and statistics are involved rather than psychology, sociology or other less precise disciplines.

Given the accuracy characterising the decisions made via the use of such instrument, many researchers and practitioners started considering it as a key element in the decision-making process, therefore resorting to the same both in theoretical and practical approaches.

Thus, we encounter scientific papers and books treating such topic, since older times, it being perceived via its application to various fields and areas of activity, like politics (Spillius, 1957), marketing (Cross, 1961 or Kotler, 1967), management (Miller, Starr, 1969), economics (Beilby, 1975), demography (Cibej, 2002), transports (Hansen, 2006), with focus on security aspects (Lee et al., 2008), engineering (Cao, Nassari, 2014), health (Euro Working Group, 20111 or Brandeau, 2016), social issues (Lee, Kuo, 2017) and many others.

The spreading of the operational research approach arises also from the high number of journals specifically dedicated to the study of the same, such as: Management

Science, Operations Research, Interfaces, European Journal of Operational Research, Journal of the Operations Research Society, Omega, International Transactions in Operational Research or Journal of Multi-Criteria Decision Analysis (Ormerod, Ulrich, 2013)

On the other hand, operational research has become a field of interest largely required in terms of professional training, being deemed, nowadays, to be a premium, stand-alone profession.

3. Research methodology

Given the fact that our approach relating to operational research is highly general and theoretical, not being dedicated to the treatment of effective, practical aspects of the same, and subject to the restrictive maximum length of the paper, the research methodology used herein is rather descriptive, as an attempt to determine, depict or identify what is, unlike analytical research that stands for establishing why it is one way or another or how it came to be that way (Ethridge, 2004).

The linear programming or the basic optimisation problem, on one hand, and the specific distribution problem, usually known as the transportation problem, on the other hand, are tools at hand when discussing in terms of operational research, beside many others such as convex programming, dynamic programming, optimisation graphs or expectation-based problems.

The first mentioned one, namely the generic basic optimisation problem, is related to the optimisation of an established goal ($f(x_1\ldots x_n)$), for instance, to either the maximisation (1) of profit, subject to the cost-specific constraints ($g_1(x_1\ldots x_n)\ldots g_m(x_1\ldots x_m)$), or to

the minimisation (2) of the incurred costs, given a certain desired level of outcome.

$$\begin{cases} \textbf{Max } f(x_1\ldots x_n) \\ s.t.c. \begin{cases} g_1(x_1\ldots x_n) \leq b_1 \\ \quad \ldots \\ g_m(x_1\ldots x_n) \leq b_m \end{cases} \\ x_1 \geq 0 \ldots \ x_n \geq 0 \end{cases} \quad (1)$$

$$\begin{cases} \textbf{Min } f(x_1\ldots x_n) \\ s.t.c. \begin{cases} g_1(x_1\ldots x_n) \geq b_1 \\ \quad \ldots \\ g_m(x_1\ldots x_n) \geq b_m \end{cases} \\ x_1 \geq 0 \ldots \ x_n \geq 0 \end{cases} \quad (2)$$

This type of problem can be solved by resorting to a graphical representation, by making use of the Simplex algorithm, based on the Gauss Jordan equations, or by appealing the Lagrange function.

A large variety of such basic or more complex optimisation problems can be built on the grounds of this principle, rendered above in a canonical form, the problem providing interesting pieces of information to the decision-maker, however the number of solution being, often, either infinite or inexistent.

The art of the manager, in such circumstances, consists in reformulating the optimisation problem to as to make it properly functional, this involving, sometimes, the decrease of the number of variables considered or of the number of restrictions taken into account, therefore opening the road for a scientific approach of the issue.

The particular optimisation-based specified tool, namely the transportation problem, is related to the discovery of the best way of distributing miscellaneous items, in various quantities (x_{ij}), from the m storage locations (D_i) towards the n consumption destinations

(Cj), in terms of efficiency, namely by minimising the overall transportation cost, given the unitary expenses (aij).

	C₁		Cⱼ		Cₙ		Avail
D₁		a_{11}		a_{1j}		a_{1n}	$T_{avail}D_1$
	x_{11}		x_{1j}		x_{1n}		
Dᵢ		a_{i1}		a_{ij}		a_{in}	$T_{avail}D_i$
	x_{i1}		x_{ij}		x_{in}		
Dₚ		a_{p1}		a_{pj}		a_{pn}	$T_{avail}D_p$
	x_{p1}		x_{pj}		x_{pn}		
Nec	$T_{nec}C_1$		$T_{nec}C_j$		$T_{nec}C_n$		T_{avail} T_{nec}

Identifying the best path for directing such items, with minimum costs for the sender, can be done via several methods, the largely known ones being the North-West corner method, the minimum per lines method, the minimum per columns method or the minimum per table method, the arising final values being compared against one another, the lowest of them being deemed the one to be considered. In this case too, various similar values can occur, situation in which additional analysis for identifying the best variant or variants, as the case may be, should be performed.

4. Results and discussions

The significant number of possibilities being at the disposal of decision-makers, be they quantitative or qualitative by nature, allows them in making seriously grounded, pertinent decisions.

However, in all circumstances when such decisions are tremendously important in the overall context, when the implications of the same are significant for many people or on long-term, when other processes are highly dependent of the quality of the same, the quantitative approach becomes a compulsory aspect.

Fortunately, operational research, also known, as above specified, as the management science, comes with various alternative tools, useful in treating different managerial decision-based aspects: for rendering the labour activity more efficient, for improving the logistic process, for making the organisation more profitable via the augmentation of the production volume or via the decrease of the associated costs and so on.

The solutions got by resorting to such helpful elements can be singular (the most precise case), multiple, up to infinite, or even missing, the last case imposing some serious measures related to the reconsideration of the entire situation.

If we talk about a basic optimisation problem related to the production of the highest possible quantity of products, with technological restrictions as for the available quantity of inputs necessary for obtaining the same, and the non-negativity restrictions for variables, standing for the existence of the said elements, we should find, in fact, that optimum production process making use in the most fruitful way of the existing resources, combining them so as to get the maximum of it, with minimum possible losses, therefore achieving the highest real level of efficiency.

We are going to find, in this case, how much of each input we might use for each type of product, considering the limited quantity of each such input and the need for it in order to create each type of product. Not too complicated at first sight when dealing with a quite low number of types of products to provide and with a quite low volume of the same. However, when having to do with important ranges and volumes, things become too complicated to be solvable without resorting to an optimisation instrument.

If this production problem succeeds in being solved in the best possible way, distributing the products to the storehouses of the organisation or from the same up to the selling points, or from the storehouses up to the customer door (mainly where talking about online orders), in due time, without investing too much in the transportation costs, while minimising also the delivery times, would become the concern of any manager in charge with such process.

Discussing about the latter case, the delivery of these products to customers, we can easily identify, especially by using a chart making us visualise the locations, which storehouse is closer to each customer. But the arising problem in this situation is that a limited quantity of products is to be found in each storehouse and, hence the difficulty in correctly approaching the issue.

The transportation problem, via its provided methods, supports our delivery-related decision, revealing the most cost-efficient network of paths from storehouses to customers usable in such context.

These are just simple examples of the usefulness of such instrument – operational research, via its briefly depicted tools out of the impressive "arsenal" of the same – in correctly dealing, in term of efficiency, with managerial decision-making processes.

Given the increasingly competitive environment we have to face in this quickly progressing, speed society, all managers desiring to stand in front of their opponents should strive for getting access to the state-of-the-art, cutting-edge means in scientifically grounding their decisions, without ignoring, on the other hand, the fact that, finally, such decisions are made by human beings, the only ones able in realistically appreciating the particular cases, in choosing the most appropriate tools and in properly construing the results provided by these supportive elements, therefore, the only ones able to reach, based thereon, the desired efficiency.

5. Conclusions

Operational research, a discipline incorporating a series of other sub-disciplines and covering, in terms of solutions provided, a large number of others, both related and unrelated to it, becomes an essential instrument in approaching decision making processes, its importance becoming more obvious when dealing with managerial issues.

Operational research is centred around the concept of optimisation, or, otherwise said, of finding the optimum solutions to the existing problems, the tools useful in this respect being quite extensive from the perspective of their number, as well as from the perspective of their complexity.

Starting from linear programming, passing towards the convex programming, up to the dynamic one, treating things via the theory of graphs and, going forward, by resorting to neuronal networks, operational research has far exceeded the tight circle of an academic discipline, the same turning into a real profession, somehow revolutionising the management activity as a whole.

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