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The Use of Quantitative Techniques and Their Role in The Administrative Decision-Making Process in Organizations

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Abstract - Due to the developments taking place in the field of communications, informatics systems and knowledge management in the current century, and the obligations and burdens imposed on the business organization to keep pace with these developments, the traditional methods of administrative decision-making are no longer feasible, as recent trends have emerged in management that focus on the need to rely on quantitative methods such as operations research. . The latter is one of the results of World War II, which appeared for the first time in Britain to manage war operations. The first method used in this field is the linear programming method. The use of operations research has developed greatly in the past years, and the methods of analysis in operations research have become tools to address many problems to assist managers in decision-making, such as maximizing profits, minimizing costs, transportation and appointment problems, etc.

Keywords: administrative decision, organization process, quantitative techniques, management

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1. Introduction

1.1 Axis One

The conceptual framework of quantitative methods and their historical development.

i. The concept of quantitative methods

Quantitative methods are considered a mathematical method through which economic, administrative and marketing problems are addressed with assistance of available resources of data, tools and methods. It is therefore essential that managers use relevant quantitative methods/ the methods that offer a variety of solutions to choose the best option to tackle problems and thus make effective decisions. [1],[19]

ii. Definition of quantitative methods

It can be defined by several definitions, including: "a set of methods, formulas, equipment and models that help in solving problems on a rational basis. [2]

- From this definition, we can include the various methods under a more comprehensive title, which is operations research, as there are several definitions, the most prominent of which are.
- The definition adopted by the British Operations Research Association as "the use of scientific methods to solve complex dilemmas in managing large systems of manpower, equipment, raw materials, and funds in factories, government institutions, and the armed forces

The American Operations Research Society has adopted the following definition:

"Operations research relates to making scientific decisions about how to design the work of equipment systems, manpower according to conditions that require their allocation in scarce resources [3], It can also be defined as the application of the scientific method in solving problems. [5]

(Leedy & Ormrod 2001; Williams, 2011) describe the research methodology as the holistic steps a researcher employ in embarking on a research work Therefore, a quantitative research method deals with quantifying and analysis variables in order to get results. It involves the utilization and analysis of numerical data using specific statistical techniques to answer questions like who, how much, what, where, when, how many, and how. Expatiating on this definition, Aliaga, and Gunderson (2002), describes quantitative research methods as the explaining of an issue or phenomenon through gathering data in numerical form and analyzing with the aid of mathematical methods; in particular statistics [20],[21],[22].

The following chart shows the units covered by quantitative methods in operations research:

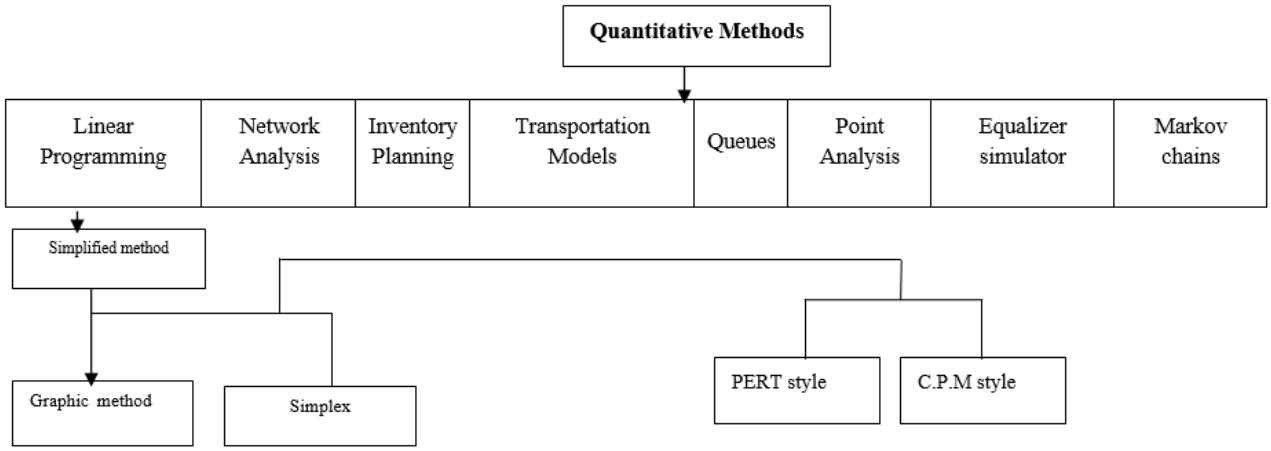

Figure 1. Types of methods used in Operations Research
(Source*: Suhaila, Abdullah Saeed, Reference previously mentioned)*

iii. Historical development of operations research:

The science of operations research has a history that is not old, and it is considered one of the sciences that contributed during World War II (1936) to the victory of the land, air and British forces, and the idea at that time was that improving the use of weapons and existing tasks give better results in the short term, than if the focus was on using available resources [6]

Much credit is due to the scientist G. Dent Icing who discovered the Simplex algorithm with advanced capabilities in solving linear programming problems, this is for the use of war operations research science in Britain, while in America it was:

B. James, Chairman of the National Defense Research Committee and B.Rannivar, Chairman of the New Weapons and Equipment Committee behind the use of Operations Research by conducting studies similar to British studies by forming a special team to address some complex problems, such as the problem of transporting various equipment and materials and distributing them to various military units deployed in different regions of the world in October 1942, General Spaatz, Commander-in-Chief of the Eighth Air Force, sent a message to the general commanders of the Air Force recommending that groups of scientists should be included in the analysis of operations in their units, and through that he formed the first team for this purpose in Britain, then followed by the US Navy, which in turn formed two teams in two huge projects: the Naval Equipment Factory, the Tenth Fleet headed by: M.Philip and J.Ellisa, and due to the success achieved today, the military leaders continued their interest in this science through the Operations Research Agency, which later turned into the Operations Research Foundation . This is what encouraged to use of this science in many other countries, led by Canada, which formed a team tasked with producing military equipment through the optimal use of available resources. After the Second World War, businessmen who were looking for solutions to their problems were encouraged to introduce this science into the management of economic projects ,In Britain a group of interested parties formed the Operations Research Club, which was named after the Operations Research Society of the United Kingdom, which oversaw the issuance of a quarterly scientific journal, starting in the year1950,which is considered the first of its kind, while in Alo, M, A the American Operations Research Association and the Scientific Management Institute were formed in 1950 and in turn issued the Operations Research Journal in 1952. [7],[20]

The use of this science has developed remarkably, especially in light of its coincidence with the great scientific development that has been achieved in the field of automatic calculations.

iv. Stages of Operations Research Development

The stages of development of Operations Research Also known as O.R stages and process, which contains six important steps, these six steps are arranged in the following order;

Step one : Observe the problem environment
Step two: Analyze and define the problem.
Step three: Develop a model.
Step four : Select the appropriate data entry.
Step Five: Submit a solution and test its plausibility
Step Six: Implement the solution

v. The importance and uses of the science of operations research:

The importance of operations research is summarized as follows:

- Assistant instrument in making quantitative decisions using modern scientific methods.
- The science of operations research is considered one of the scientific methods that help in making decisions in a more accurate manner and far from randomness resulting from trial and error.
- Operations research is an art and a science at the same time, It is related to the efficient allocation of available resources, as well as its new ability to reflect the concept of efficiency and scarcity in applied mathematical models.
- This science seeks to search for new rules and foundations for administrative work, in order to reach the best levels in terms of comprehensive quality, and international standards (ISO).
- It helps to deal with complex problems through analysis and solution, which are difficult to deal with in their normal form.
- It helps to save the cost of solving various problems by reducing the time required for the solution.
- It helps to focus attention on the important characteristics of the problem without going into the details of the characteristics that do not affect the decision, and this helps in identifying the appropriate elements for the decision and using them to reach the best. [5],[19]

We can show the uses of operations research through the sequential form.

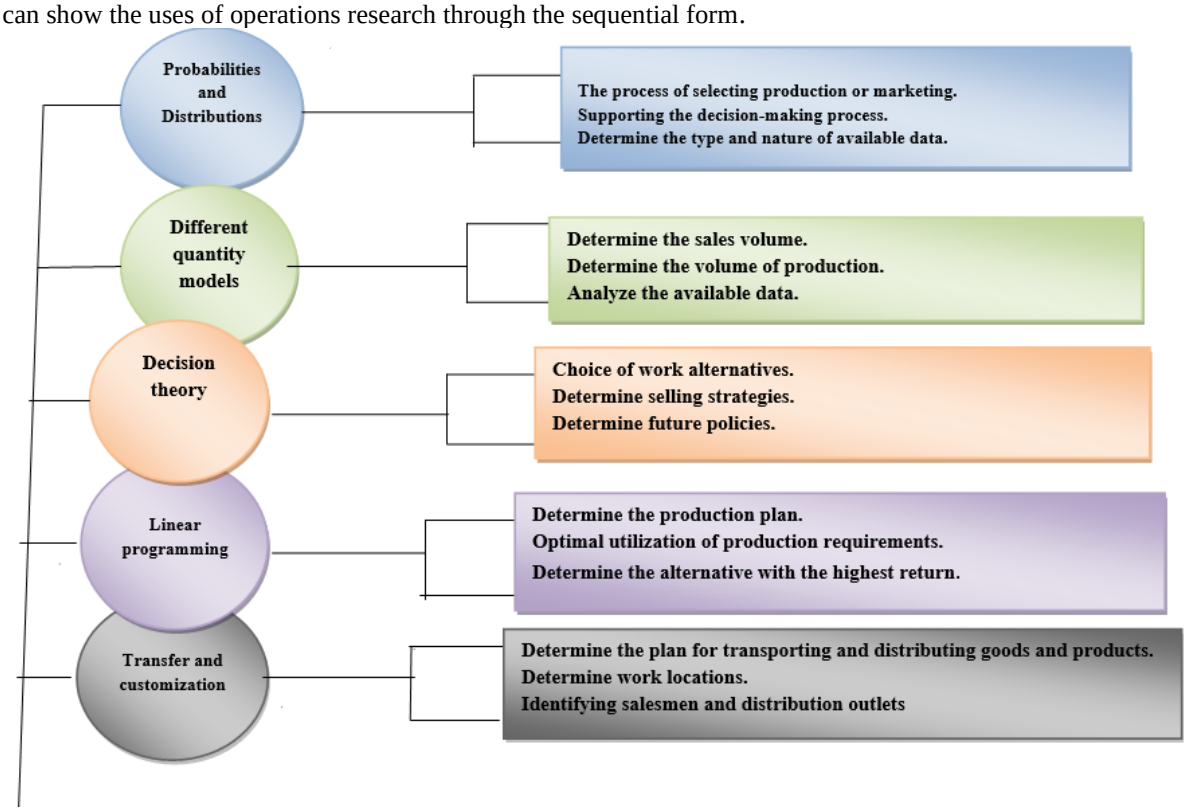

Figure 2: Application of quantitative method methods: according to the stylistic approach

Source: Muayad Abdul-Hussain Al-Fadl, "The Quantitative Approach in Business Administration: Decision Models and Practical Applications," 1st edition, Dar Al-Wareq, 2006,

1.2 Axis Two

Making Administrative Decisions

i. The concept of decision-making

It is the essence and core of the administrative process in any project, and in general it is defined as the choice of the aware and conscious and based on verification and calculation in choosing the appropriate alternative from among the available alternatives in a specific situation, in other words, decision-making is not an automatic response and a direct unconscious reaction rather, it is choosing the appropriate alternative from among the available alternatives in a particular situation, in other words, decision-making is not an automatic response and a direct unconscious reaction, but rather a conscious choice based on measure and calculation in the details of the goal to be achieved and the means that should be used. [10]

From the administrative and practical point of view, there is a difference between decision tapring and decision-making, the first, we explained its concept above, while decision-making, which is now considered the focus of

scientific research to issue rational decisions resulting from industry, in the sense that decision-making has inputs that lead to outputs, and this means studying the inputs of decision-making to be rational and implementable in line with the prevailing production conditions. [7], which includes all the stages that would lead to the decision-making process, while the latter means the selection and implementation stage of decision-making

Studying the defects of decision-making to be rational and implementable in line with the prevailing production conditions. [11], which includes all stages that would lead to the decision-making process, while the latter means the selection and implementation stage of decision-making.

In view of the importance of defining the concept of decision-making, many writers and researchers specializing in administrative sciences, especially those who specialize in the field of organizational behavior and human resources, the purpose of this is to define a scientific concept of the decision that can agree or deviate from the prevailing concept that was previously discussed.This is as follows: [10]

Young: "Decision is defined as the effective response that provides the desired results for a particular situation or group of potential situations in the organization."

As for Harrison: Decision is defined as "the moment in the process of evaluating the alternatives related to the goal, at which the expectation of the decision-maker with regard to a specific action in particular made him make a choice that directs the mechanism of his capabilities and energies to achieve his goals."

From these definitions, it can be concluded that decision-making is the process of choosing between a set of alternatives under the availability of certain conditions to achieve controlled results and goals.

2. Decision-making stages: we can show them through the following figure:

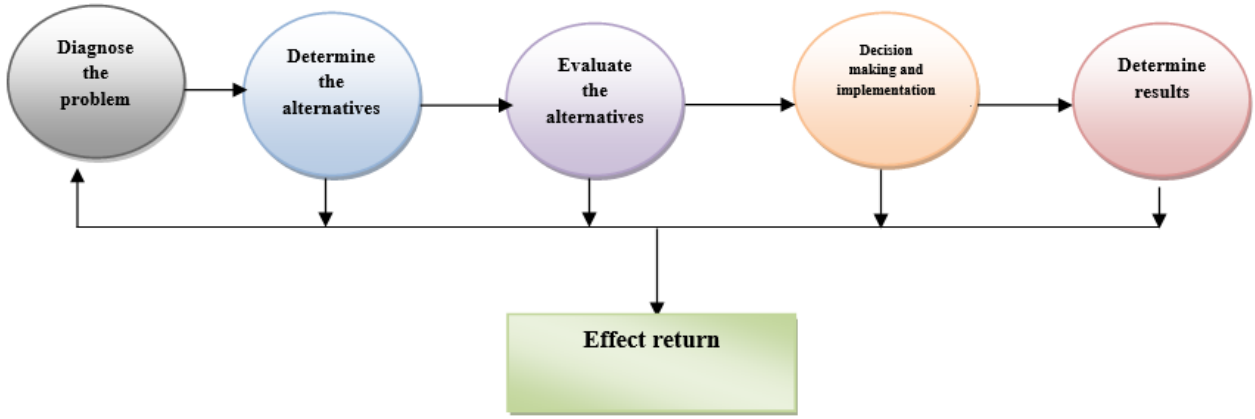

Figure 3: Decision making stages

Source: Jamal Al-Din Laawaisat, "Management and the Decision-Making Process, Dar Huma," United Arab Emirates

Since the figure shown above includes the major stages of decision-making, the stages can be accurately identified as follows;

1- The stage of realizing the problem: that is, the awareness of the decision-maker that there is a specific problem, and a decision must be taken to solve it.

2 - Determine the decision criteria: that is, the criteria by which we can judge the feasibility or futility of the decision taken, for example: the criterion may be choosing that act that achieves the largest net present value in the case of investment decisions that include a number of potential machines to buy. [13]

3 - Determine the weights of necessary criteria for decision-making.

4 - Determine the available alternatives and exclude the bad ones.

5- Selecting and evaluating each alternative: by identifying variables that can be easily measured (revenues, costs, time...)

6- Choosing the best alternative from among the alternatives and issuing the decision: This is done through 3 starting points: experience, experiment, research and analysis. The last premise is the most widely used and effective method for defining the problem.

7- Decision-making and its implementation along with its follow-up and evaluation: since the decision-maker's task does not end only when it is implemented, but it goes beyond following up the results of implementation in order to identify the principle of success of the chosen or optimal alternative in treating the problem or achieving the desired goal. [14]

8- Types of decisions: There are different types of decisions taken by managers or on the part of decision makers. These types are:

First: Decision-making based on achieving the goal or the achieved results, and these are represented in:

1- The optimal decision.

2- The best decision.
3- Possible decision.

Second: There are other types of decisions that depend on the availability of the factor of certainty or uncertainty and can be identified by the following types:
1- Decision-making in the case of complete certainty: It is the simplest and rarest type so that the decision-maker can determine the results of each of the available alternatives with certainty, and the reason is due to the availability of data and information.

2- Decision-making in a state of uncertainty (risk): where the decision in this case is characterized by the fact that the decision-maker is fully aware of the possibilities of any situation occurring that affects the various decision alternatives, and there are criteria that the decision-maker can use in this field, including an expected financial value criterion, loss criterion of missed opportunities.

3- Making a decision in a state of complete uncertainty: In this case, the risk ratio is very high due to the lack of past experiences for the decision-maker, in such a case, the decision-maker must make his decision based on the automated criteria to determine the best alternative and make his decision based on the following criteria to determine the best alternative and making the appropriate decision: [15],[14]
A -The maximum criterion: where the decision-maker chooses the alternatives that achieve the greatest financial return, i.e. taking the optimistic alternative.
B- The minimum maximum criterion: In this case, the decision maker is characterized by a kind of pessimism and chooses the lowest benefits.
C- Minimum maximum criterion: In this case, the decision maker is characterized by cautious optimism, that is, choosing the best results for each alternative, and then choosing the least of these results.
D- The minimum standard: Here, the decision-maker behaves with a great degree of pessimism, and this is in a great state of uncertainty for the decision-maker, so he chooses the lowest return for each alternative.
E- The criterion of remorse: This criterion was proposed by the scientist Savage, a criterion based on psychological studies, where he believes that the decision-maker, after making the decision and obtaining a certain return, may feel remorse because he knows during that period the state of nature that occurred and therefore he wishes as he had chosen an alternative other than the one he chose , and the savage scientist concluded that the decision-maker must make every effort to reduce his remorse.

4 - Decision-making models: Any manager aspires for his decisions to be fully rational, i.e. completely objective and logical, but this is not available in most cases, as the manager often makes his decisions in the light of insufficient information, thus, his decision-making models are classified into two main models:
A - The rational model: It is also called the ideal model, and it focuses on what the manager should do, It is based on the economic theory that looks at the manager as fully rational and seeks to achieve maximum profits,It assumes that the manager has the following characteristics:
-Full knowledge of all available alternatives.
-He has full knowledge of the outcome of each alternative.
- He has the ability to objectively evaluate the outcome of each alternative.
- He has an ordered and fixed system of preferences (values and standards);
B- The behavioral model: (17) Many writers believe that the assumptions on which the rational model is built are rarely achieved and all of them are available, because:
* The decision maker does not have complete or accurate information;
* The decision maker does not have information about all the available alternatives and does not have a full understanding of the nature of the alternatives and what he will choose from it;
* The decision-maker has rational limits for decision-making based on a set of values , experiences and habits, etc.;
* The decision-maker will choose that alternative that achieves the highest degree of satisfaction or benefit, as Herbert Simon believes that: “The administrator is satisfied with the satisfactory decision, instead of seeking to reach the optimal choice.”

The writer Luthans adds to the two previous models a third model, which is: [14] the inductive-judgmental model, and it is also called the intuitive model, where the decision-maker relies on the individual's estimation, intuition, and judgment based on scientific experience and not scientific knowledge, and on trial or error, but this approach in turn leads in the availability of certain circumstances to errors and biased results in an organized manner.

5 - Methods of quantitative method in decision making:
Some specialists in administrative sciences have gone specifically with the methods of the quantitative approach to business administration to focus on operations research more than the rest of the other names, In other words, they went

to consider that the quantitative approach to business administration is based on one basic rule, which is operations research, for the following reasons:
It is a science that relies on examples in results and solutions.
* Addressing problems that are characterized by limited resources and enumerate alternatives.
* It is involved in addressing many problems in the practical reality of business organizations, in addition to that it raises the origin of military sciences.
There are many methods used in operations research, each according to the issue or problem to be solved, and some of them are
- Linear programming method and integer programming.
-Transfer modes.
-Business networking style.
-Inventory control method.
-Markov analysis method.
-Waiting line style.
The following table shows more methods of operations research, each according to its uses in the business organization.

Table 1: The structure of the matrix for the use of operations research methods in the functions of the establishment within the business organization.

Financial management	Human Resource Management	Storage	Transportation and marketing	Production and operations management	Jobs / Styles
Optimal Distribution of Current Resources	Optimal Utilization Of Human Resources			Production Planning	Linear Programming
		Transfer Of Purchases from The Store	Factories Marketing	Circulation Between Production Lines	Transfer Models
			Flow Of Resources and Goods	Projects Execution	Business Networks
Determine The Best Invested Benefit		Determine The Best Source Of Purchase		New Product Launch	Decision Analysis
		Determine The Economic Batch Size			Stock Control

Source: Muayad Abdul-Hussein Al-Fadl, reference previously mentioned

2. Case Study

In practice, it depends extensively on the various techniques of operations research, which are used in solving economic issues, among the most important of these techniques, we find linear programming, as the latter is applied in order to achieve a major goal of any economic institution, which is maximizing profits, under certain constraints, the following applied example in order to learn how to use linear programming to reach the optimal solution to any problem or economic issue and thus make the appropriate decision:

Example: An industrial establishment that produces two types of products p1, p2, and the production process passes through three stages through three workshops A1, A2, A3, where the unit production of the product P1 requires the exploitation of 2 hours of work in the workshop A1, 1 hour in the workshop A2, and 5 hours in the workshop A3. As for the production of a unit of product p2, it requires one hour of work in workshop A1, one hour in workshop A2, and 3 hours in workshop A3.The production of the p1 type achieves a unit profit of 7 DG, while the second type, p2, also achieves a unit profit of 4 DG. The machines used in workshop A1 operate with a maximum capacity of 140 hours, while the energy available for machines in workshop A2 is 104 hours, as for workshop A3, machines with a maximum capacity of 360 hours are used. What is required is writing the economic issue in mathematical form (linear program) in order to maximize profits?

The solution:
Finding the Linear Program for Profit Maximization:
The Previous Data Can Be Summarized In The Following Table;

Workshops / Product	A_1	A_1	A_1	Profit
p_1	2	1	5	7
P_2	1	1	3	4
Inventory	140	104	360	-

For this we take the following steps:
First: Defining the variables: as follows
x1 is the quantity produced from p1.
x2 is the quantity produced from p2.

Second: Writing the objective function as follows;

$$MaxZ = 7x_1 + 4x_2.$$

Third: Write the Constraints as follows;

Constraint A1
Constraint A2
Constraint A3

$$\begin{cases} 2x_1 + x_2 \le 140. \\ x_1 + x_2 \le 104. \\ 5x_1 + 3x_2 \le 360. \end{cases}$$

Writing the linear program-

$$\begin{cases} 2x_1 + x_2 \le 140. \\ x_1 + x_2 \le 104. \quad x_1, x_2 \ge 0 \\ 5x_1 + 3x_2 \le 360. \end{cases}$$

$$Max(Z = 7x_1 + 4x_2).$$

*Finding the optimal solution for production and maximum profit using the algebraic method:
Passing from inequalities to equations by adding complementary variables

$$2x_1 + x_2 + x_3 = 140.$$

$$x_1 + x_2 + x_4 = 104.$$

$$5x_1 + 3x_2 + x_5 = 360.$$

$$Max(Z = 7x_1 + 4x_2 + 0x_3 + 0x_4 + 0x_5).$$

x3,x4,x5) base variables(
x1,x2) variables outside the base(
-Find the first basic solution: (x1=x2=0).
Writing the base variables in terms of variables outside the base is as follows;-

$$x_3 = 140 - 2x_1 - x_2.$$

$$x_4 = 104 - x_1 - x_2.$$

$$x_5 = 360 - 5x_1 - 3x_2.$$

$$Max(Z = 7x_1 + 4x_2 + 0x_3 + 0x_4 + 0x_5).$$

Substitute the value of (x1 = x2 = 0). We find

$$x_3 = 140.$$

$$x_4 = 104.$$

$$x_5 = 360.$$

$$MaxZ = 0.$$

The presence of positive coefficients in the objective function It means that the solution was not the best solution ..
- Finding the second basic solution: The variable that enters the basis is the one that accompanies the largest positive coefficient in the original objective function X1.
:x1 enters the base and we make the rest of the variables equal to 0. We find-

$x_1 = 70.$

$x_1 = 104.$

$x_1 = 72.$

The variable that comes out of the base is the one that accompanies the lowest value of x1, i.e. x3, that comes out of the base. From it, the base becomes as follows:
(x1,x4,x5) base variables
(x3,x2) variables outside the baseline. (x3=x2=0)
:-Writing the base variables in terms of variables outside the base is as follows

$$x_1 = 70 - \frac{1}{2}x_2 - \frac{1}{2}x_3.$$

$$x_4 = 34 - \frac{1}{2}x_2 - \frac{1}{2}x_3.$$

$$x_5 = 10 - \frac{1}{2}x_2 - \frac{5}{2}x_3.$$

$$Max\left(Z = 7\left(70 - \frac{1}{2}x_2 - \frac{1}{2}x_3\right) + 4x_2\right)$$

$$Max\left(Z = 490 + \frac{1}{2}x_2 - \frac{7}{2}x_3\right).$$

The presence of positive coefficients in the objective function means that the second fundamental solution is not is not the best..
-Finding the third base solution: The variable that enters the base is x2.
x2 enters the base and we make the rest of the variables equal to 0. That is;

$x_2 = 140.$

$x_2 = 68.$

$x_2 = 20.$

The variable that comes out of the base is x5, and from it the base becomes as follows:
(x1,x4,x2) base variables.
(x3,x5) variables outside the baseline.
-Writing the base variables in terms of variables outside the base as follows

$$x_2 = 20 + 5x_3 - 2x_5.$$

$$x_1 = 60 - 3x_3 + x_5.$$

$$x_4 = 24 - 2x_3 + x_5.$$

$$Max\left(Z = 490 + \frac{1}{2}(20 + 5x_3 - 2x_5) - \frac{7}{2}x_3\right).$$

$$Max(Z = 500 - x_3 - x_5).$$

Hence the third basic solution is the optimal solution as follows;

$$x_1 = 60, x_2 = 20.$$

$$x_3 = 0, x_4 = 24.$$

$$x_5 = 0$$

$$Max(Z = 500).$$

3. Interpretation of economic results

The decision of the establishment is to produce 60 units of product p1 and 20 units of product p2, using all the stock of the maximum capacity of the machines in workshop A1 and workshop A3 (there is no idle energy), with a portion of

the energy remaining in workshop A2 estimated at 24 hours of unutilized work (they are exploited only 80 hours of work). And the establishment thus achieves a maximum profit of T = 500 monetary units.

If the organization wants to determine the range in which it can change the profits of product p1 while maintaining the same situation (maximizing profits,
Max z=500). We can know this by the following:
We assume that $c1^*=7+D$ and is the coefficient of x1, so the objective function becomes as follows:

$$Maxz = 500 + 60D - (1+3D)X_3 - (1+D)X_5.$$

In order for the solution to remain optimal, the following must be achieved: (Because we are in maximizing condition)

$$\begin{cases} -1-3D \le 0 \\ -1-D \le 0 \end{cases} \Rightarrow \begin{cases} -1 \le 3D \\ -1 \le D \end{cases} \Rightarrow \begin{cases} D \ge \frac{1}{3} \\ D \ge -1 \end{cases}$$

$$\Rightarrow -\frac{1}{3} \ge D \Rightarrow -\frac{1}{3} \le D \le +\infty$$

$$7 - \frac{1}{3} \le D + 7 \le +\infty + 7 \Rightarrow \frac{20}{3} \le C_1^* \le +\infty.$$

Interpretation: The establishment can change the unit profit of the product by at least 6.66 per unit.
As for the field in which you can change the available time in one or all of the workshops, for example: Workshop 1, it will be as follows:

must come true $B^{-1}b_i \ge 0$

B-1 is a matrix present in the optimal solution in place of the basis matrix in the first basic solution, as:
X4: A marginal variable that has no effect on the objective function

$$B^{-1} = \begin{bmatrix} -5 & 2 \\ 3 & -1 \end{bmatrix}$$

b1: the available quantity in the first workshop (we assume it is unknown

$$B^{-1}b_i = \begin{bmatrix} -5 & 2 \\ 3 & -1 \end{bmatrix} \begin{bmatrix} b1 \\ 104 \end{bmatrix}$$

$$\begin{bmatrix} -5b_1 & +208 \\ 3b_1 & -104 \end{bmatrix}$$

In order for the solution to remain optimal, the following must be met;:

$$\begin{cases} -5b_1 + 205 \ge 0 \\ 3b_1 - 104 \ge 0 \end{cases} \Rightarrow \begin{cases} 5b_1 \le 208 \\ 3b_1 \ge 104 \end{cases} \Rightarrow \begin{cases} b_1 \le 41.6 \\ b_1 \ge 34.67 \end{cases}$$

$$34.67 \le b_1 \le 41.6.$$

Interpretation: The establishment can vary the energy used from the first resource between 34.67 hours and 41.6 hours, without affecting the optimal solution.

4. Conclusion

After reviewing concepts related to quantitative methods and administrative decisions, and by studying the previous example, it can be said that operations research is actually one of the most important quantitative techniques used in making administrative decisions in the organization.

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