



Importance of use of operating models in the decision making: A Case Study

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Abstract:

The field of operations research is represented in an attempt to find mathematical models that express the real problem, with an attempt to develop mathematical tools that enable the solution of these models, with the aim of reaching the optimal alternative among the available alternatives to solve the problem, Hence the idea of our study, which is mainly focused on clarifying the importance of programming objectives and integer programming models in productive decision-making. These models were applied to Al-Tariq Food Products Company and General Car and Equipment Manufacturing Company, during the period 2020-2022.

Keywords: Operations research, decision making, goal programming, integer programming.



أهمية استخدام نماذج التشغيل في اتخاذ القرار: دراسة حالة

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الملخص:

يتمثل مجال بحوث العمليات في محاولة إيجاد نماذج رياضية تعبر عن المشكلة الحقيقية، مع محاولة تطوير أدوات رياضية تمكن من حل هذه النماذج، بهدف الوصول إلى البديل الأمثل من بين البدائل المتاحة لحل المشكلة، ومن هنا جاءت فكرة دراستنا التي تركز بشكل أساسي على توضيح أهمية أهداف البرمجة ونماذج البرمجة الصحيحة في اتخاذ القرارات الإنتاجية، وقد تم تطبيق هذه النماذج على شركة الطارق للمواد الغذائية وشركة تصنيع السيارات والمعدات العامة، خلال الفترة 2020-2022.

الكلمات المفتاحية: بحوث العمليات، اتخاذ القرار، برمجة الأهداف، البرمجة الصحيحة.

1. Introduction

Operations research is considered as one of the scientific means to make decisions more accurately and away from chance resulting from the application of the trial-and-error method.

The role of operations research in the decision-making process is to reduce the degree of dependence on intuition, guesswork and experience, by focusing on logical and scientific methods that are very useful in increasing the efficiency and regularity of production decisions. Therefore, operations research acquires an essential importance for management in achieving its objectives at all administrative levels, especially at the production level. In order to cover the aspects of the



subject, one must know how mathematical models for operations research can help in the productive decision-making process of the organization? What is the importance of using multi-objective linear programming model in productive decision-making process? What is the importance of using the integer programming model in the decision-making process in the organization?

Based on the above, the problem can be formulated as follows:

– **Study hypotheses**

- 1- Mathematical models for operational research help the decision-maker in the process of rationalizing the productive decision.
- 2- The use of multi-objective linear programming techniques contributes to the rationalization of the effective productive decision in Enterprise.
- 3- The importance of using the multi-objective linear programming model lies in providing several alternatives for managing the organization to circumvent the problem of choosing the optimal productive alternative.
- 4- The importance of the integer programming model lies in solving the indivisibility problem of the number of units produced.

– **Objectives of the study**

- 1- Highlighting the role of operations research models in the productive decision-making process.
- 2- The decision-making process is complicated in the economic institution it faces, which has led to abandoning old methods and resorting to tools that allow making the appropriate decision in very complex situations.
- 3- The use of operational research models as one of the mathematical scientific methods at the level of economic units, including productivity, is a new technology that increases efficiency and improves the



production system, which positively reflects on the multiple objectives of the institution.

- 4- Identify the use of multi-objective linear programming model in productive decision-making process.

2. Background Study

The researcher aims to explain and clarify the nature, importance and nature of the factors that have a direct impact on the material requirements planning system and affect production capacity planning and the relationship between the two in Iraqi industries. The most important conclusions of the researcher are that it is possible to develop a model that includes the most important factors affecting the production capacity system and the materials requirements planning system, which would increase the effectiveness and efficiency of the production system in Iraqi industries. (Al-Janab, 2024)

Integration of decision making at different organizational and temporal levels has important implications for increasing the profitability of organizations. Important problems in medium-term decision-making in factories include production planning problems that seek to determine the quantities of products produced in the medium term and the allocation of company resources. Moreover, in the short-term, work planning and timely delivery of orders are critical decision-making issues in every workshop. In this case, the production planning and scheduling problem in a factory in northern Iran is considered as a case study. The factory produces cans and tubs of various types with ten production lines. Therefore, the mixed integer linear programming



model is presented for the integrated production planning and scheduling problem to maximize profit. (Emami, et al. 2019)

3. the theoretical side

First: The concept of decision making

There are many definitions of the decision-making process developed by many authors and writers, and all of them emphasize that decision-making is based on a process of conscious and perceptive comparison between a group of alternatives, or solutions (at least two or more alternatives) available to the decision-maker to choose one of them as the most appropriate way to achieve the objective or objectives that the decision-maker wants to achieve (Morse, et al. 2003). We will discuss some of them as follows:

- We can define decision-making as the process of choosing between several available alternatives and then choosing among them after collecting and processing data, with the aim of reaching the best option that helps in achieving the set objectives. (Schwartz, 2017).
- The process of selecting an alternative from several alternatives, and this choice is made after a thorough and analytical study of all aspects of the problem that is the subject of the decision, Accordingly, the decision-making process does not deviate from being a process of comparison and choosing an alternative from among a group of alternatives to achieve certain goals, and this means that there is more than one alternative in front of the decision-maker, If there is only one alternative, then the element of choice does not exist, and the decision-maker becomes confronted with a fait accompli (Lunenbourg, 2010).



All definitions emphasize that the decision is based on a process of comparison, consciously and reflective, between a set of alternatives or solutions (at least two or more alternatives) available to the decision-maker to choose one of them as the most appropriate means to achieve the goal or goals that the decision-maker desires.

– **The significance of decision making**

Decision-making is one of the most important activities performed by civil servants in various institutions, it is also considered to be the only activity that distinguishes the behavior of the official and distinguishes other officials, and decision-making is linked to the achievement of objectives of all kinds, where there was room for choosing between more than one alternative to reach a goal, there was a need for decision-making. The decision-making process is the best choice for management, the manager's ability to reach the right decision in a situation, his skills in identifying alternatives, and persuading others to accept the decision he made are among the main factors that lead to success in decision-making (Fülöp, 2005) (Harris, 1998).

The decision-making process derives its importance in relation to the production process because it represents the starting point for all activities and daily events in the life of institutions, and because stopping to take them leads to a delay in the work and the decline of the establishment (Keeney, 2004).

Hence, the decision-making process was considered the essence of the production process, and it is the predominant work of officials, and given that, the success institution depends to a large extent on capacity and



competence of decision-makers to make sound and appropriate decisions.

– **decision making situations**

Hesitation in decision-making is one of the factors that impede the process of issuing sound decisions in a timely manner, which affects the problem and the adequacy of its solution, the hesitation in making decisions is due to the relationship between the decision and the future, and this relationship is based on the information monitored for the future and the degree of its accuracy. Often, these operations are not known accurately results in the future, which leads to decisions in different circumstances ranging from the degree of certainty to the degree of uncertainty (Vroom& Yetton, 1973) (Phillips et al. 2004).

Decision making if confirmed

The decision is necessary to find all the alternatives and results of the chain, by consequent, to determine the solution appropriate depending on the alternative choices that done the better results that the administration can improve (Saaty, 1990). It is considered the easiest case in making decisions because the outcome of the decision is the same, and this means that the problem is either related to achieving the largest possible profit or related to achieving the lowest costs from a production process (Kochenderfer, 2022).

Decision making in case of risk

The decision maker can estimate the results of each alternative because he is aware of the probabilities of each outcome and then chooses the alternative that gives the desired outcome by the administration (Sun,



2023). This case is distinguished from the previous one in that it can show several possible outcomes, and the information related to the decision problem is known or available in advance, so models are used in which weighting coefficients are used for each expected or possible normal case, i.e. the expected possibilities (Gärdenfors, 2005).

Decision making when uncertain

The remarkable feature of this case is that it does not have prior information to determine weighted coefficients, and the circumstances surrounding the decision-making differ according to time and place, Therefore, the decision maker in this case will depend on the outcome of each decision in order to choose the optimal or most appropriate decision that fits the current circumstances, Also, the decision-maker may use his personal estimates based on previous experience and expertise. This type of case is usually in line with light commercial operations that are practiced on a daily basis, and thus the trader gains experience with limitations about the Surrounding environment in which he exercises his activity, such as knowing the real customers and thus knowing the demand for the commodity (Gärdenfors, 2005) (Kochenderfer, 2022).

Second: the most important quantitative methods of operations research used in decision-making

Operations research methods make the decision-making process more rational, efficient and highly efficient in the process of comparing and selecting among available alternatives, and this in the various functions of the institution, including production, marketing, financing and individuals within the surrounding internal and external environment, In pursuit of a specific goal or objectives (Morse, et al. 2003). Operations



research methods or models help to streamline the decision-making process in all functional areas of the organization in general, and by making productive decisions in particular. In this strand, we discuss the most important operations research methods and models as follows:

A. Multi-objective linear programming

Historically, Cooper and Ferguson are credited with the emergence of the idea of goal programming, and it was then that the General Electric Company entrusted them in the year 1952 with the preparation of a salary scale for the workers of one of the company's production departments, Provided that these salaries take into account the achievement of a certain number of objectives, in particular that they are proportionate to the level of responsibility entrusted to the holder, to the value of the service expected, to the standard of living, to the motivation, to the growth of the establishment, the increase in experience, and other objectives. Therefore, they were able to come up with a mathematical model that works to reduce the deviations from the specified set of goals to the lowest possible extent (Wang, 2004). Since then, the multi-objective programming method has been knocking on many doors every day in areas of practical application such as manpower planning, Real estate appraisal and portfolio management. What helps to increase these areas and the possibilities of their future expansion is the development of special programs for electronic computers to solve the problems of programming goals in a more effective way from the computational point of view (Ji, et al. 2018).

either the mathematical model of multi-objective linear programming problem (Nahar, et al. 2023) (Tantawy& Sallam ,2009)



$$\max \text{ or } \min G_s(x) = \sum_{y=1}^n c_y x_y, \quad s = 1, 2, \dots, s$$

Subject to:

$$\sum_{y=1}^n a_{iy} x_y (\leq, =, \geq) b_i, \quad i = 1, 2, \dots, m$$

$$x_y \geq 0, y = 1, 2, \dots, n$$

B. Integer programming

In many cases, the values of decision variables are integers. For example, when choosing the cheapest combination of aircraft to purchase based on price and based on maintenance and capacity, in such a case it is not reasonable for the numbers of aircraft to be in fractional form (Taha, 2014). When using linear programming to solve the optimization problem and under certain constraints, two conditions must be taken into account: the variables must be continuous and the objective function plus the constraints are linear functions. In such cases, we resort to other methods and techniques of resolution, represented by the programming of integers (Schrijver, 1998).

The integer programming model is considered as one of the mathematical models derived from the general mathematical model of linear programming, and it consists of an objective function, constraints, and the non-negative condition of the variables. It differs from ordinary linear programming in that one or more of the solution values must be in integer form and in particular in the table of optimal solutions, i.e., the values of the decision variables must be integers with no fractions;



Integer programming can be defined as a mathematical method of linear programming that provides solutions to linear programming problems in the form of numbers or integers (van Doornmalen, et al. 2023). to solve the integer programming model, many methods are used, the most famous of which are: Gomory constraint, and the method of branch and bound. either the mathematical model of the integer programming problem:(Almeida, et al. 2024) (Hooker, 2024)

$$\max \text{ or } \min (Z) = x_u \sum_{u=1}^n c_u \quad x \geq 0$$

Subject to:

$$b_u \left(\begin{matrix} \leq \\ = \\ \geq \end{matrix} \right) x_u \sum_{i=1}^m a_{iu}$$

$$x_u \geq 0, \quad x_u \text{ integer}$$

Value $c_u, \forall u = 1, \dots, n$ are referred to as objective coefficients, and are often associated with the costs associated with their corresponding decisions in minimization problems, or the revenue generated from the corresponding decisions in maximization problems. the value a_{iu} are the right-hand-side values of the constraints, and often represent the value are the right-hand-side values of the constraints, and often represent amounts of available resources (especially for $\leq$ constraints) or requirements (especially for $\geq$ constraints). The b_u values thus typically denote how much of resource/requirement i is consumed/satisfied by decision j .

4. The applied side

An applied study of the multiple-objective programming model and integer programming



1. Applying the multi-objective programming model to Al-Tariq Food Products Company

This study focused on how to construct a multi-objective programming model to contribute to the firm's production decision-making. This study addressed the production structure of Al-Tariq Food Products Company during the period (2020-2022) by addressing the stages of the production process and then evaluating the company's production activity during the same period. After that, the mathematical model was built by formulating the hypotheses of the multi-objective linear programming model, specifying the goals that the company seeks to reach in light of production constraints. Finally, the linear program was solved using quantitative methods software, with interpretation and sensitivity analysis of the results obtained. (Zeleny,2012).

Finally, the proposed production plan was compared with the plan of the institution under study during the year 2020, where the study concluded that the institution can increase production by 166% percent compared to what it achieved during the same period, while reducing deviations from the values of the set goals to the lowest possible value for them. As shown in the following table:

This method that Gomory arrived at depends mainly on the simplex method through which we get an optimal solution with real values, where at first the solution is done according to the normal simplex method, if the optimal solution is correct then it is the required solution, but if some or all of the optimal solution is a fraction (decimal) then we will choose the largest of these fractions to have a new constraint added to the end of the last simplex table that we obtained, and then the



solution is completed using the corresponding simplex method, and thus we continue the solution and the same steps are repeated until reaching the correct optimal solution. The Gomory constraint method is a very effective method for solving integer programming problems, but it is time-consuming due to the large number of iterations, especially in large problems.

Therefore, the calculation was done as follows: $[(\text{proposed production} - \text{actual production}) / \text{actual production}] * 100$.

Table 1: Proposed production quantity and actual production quantity for the year 2022

Production	Proposed production quantity	Actual production quantity	Difference percentage
A	154000	84000	83.33
B	260000	140000	85.71
C	2304	2000	15.2
D	12000	144000	91.67–
E	72000	78000	–7.69
F	288000	240000	20
G	5024	3245	54.82
H	8524	5842	45.90
I	4225	2944	43.51
J	1054	6232	–83.08
the total	939131	572551	166.03

2. Applying the integer programming model in the General Company for the Automotive Industry In this study, we discussed how to build and apply a mathematical model that helps the General Automotive



Manufacturing Company face the problem of determining the optimal production quantity that it seeks to achieve its goals in light of the indivisibility of its products. According to the hypotheses that the use of integer programming techniques contributes to the company's production planning, building a mathematical model for integer programming requires us to carefully study the production stages, in addition to their techniques that help management facilitate the production planning process through sensitivity analysis by giving the decision maker an opportunity to address the sudden changes that occur in the organization's production process. Our study included the use of only one method, which is the integer programming technique. It was also limited to the spatial and temporal areas specified in the study of the General Company for the Automotive Industry within a year 2021. (Najah & Jazzaa 2022) To build a mathematical model for the institution under study, the production cycle of the institution was addressed by tracking the stages of production and preparing products from beginning to end, then determine the hypotheses for applying the model, which are: The hypothesis of determining the organization's goal, the hypothesis of products, the hypothesis of units of measurement and the hypothesis of raw materials. Finally, the mathematical model was solved using quantitative methods programming and sensitivity analysis.

Finally, the proposed production plan was compared to the plan of the establishment studied during the year 2021, It was concluded that the organization can increase the production range by 5% compared to what it achieved during the same period, while achieving a maximum turnover of 5149204000\$ As shown below:

**Table 2: Proposed production quantity and actual production quantity for 2021**

Production	Quantity of production Proposed	Quantity of production	Difference	MIN	MAX	THE METHODE $\frac{def}{M}$	Difference obtained (%)
A	87	133	-46	87	M	$\frac{-46}{133}$	-34.58
B	96	85	11	-M	96	$\frac{11}{85}$	12.94
C	333	729	-396	333	M	$\frac{-396}{729}$	-54.32
D	955	595	360	-M	955	$\frac{360}{955}$	60.50
E	515	336	179	-M	515	$\frac{179}{515}$	53.27
Total	1986	1878	108				5

5. Conclusions and Perspectives

This study demonstrated the importance of applying quantitative methods for operations research at the economic enterprise level, by relying on the multiple-objective programming and integer programming models in order to make production decisions, That is, the optimal production configuration has been determined to help achieve a set of goals that the institution seeks to achieve in the form of mathematical restrictions, It was concluded that the total production rate of the institution is low compared to the proposed program, which means that both institutions are not exploiting the total available production capacity due to the limited available primary resources used in the process production, in addition to the absence of a production analysis system that allows both institutions to understand and solve



various production problems by choosing the appropriate quantitative tools to make the optimal production decision. Based on this, it is better for the two institutions studied to avoid the current production program, and follow the proposed linear program in accordance with the results of the applied study.

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