Use of the Goal programming to reduce cost, time and optimization in the production lines of the General Company for Electrical Industries in Iraq

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ملخص :

يتناول هذا البحث استخدام أساليب بحوث العمليات للوصول إلى الحل الأمثل لمشاكل خطوط الإنتاج باستخدام طريقة) برمجة الهدف (لما تتصف به من إمكانية في التعامل مع مسائل الواقع العملي في معالجة عدة أهداف في أن واحد بدلا من هدف واحد،وتم استعمال أربع معادلات لدالة الهدف وهي) تعظيم الربح والكمية بالإضافة إلى تقليل الوقت والكلف (،تم تطبيق الجانب العملي في معمل إنتاج المحركات - الشركة العامة للصناعات الكهربائية – بغداد ومن خلال جمع البيانات اللازمة لاجزاء المحرك) مجمع الغطاء الأمامي ، مجمع الغطاء الخلفي ، مجمع السستير ، مجمع الروتر ، ومجمع لوحة التوصيل (ثم صياغة أنموذج رياضي يحقق (4) أهداف بشكل متوافق باعتماد مبدأ الأولوية ,Win QSBلتكوين خطة إنتاجية شهرية لمنتج محرك مبردة الهواء بتوظيف برنامج الحاسوب الجاهز وتشير النتائج إلى أن الربح بلغ (1351)دينار وقلت الكلفة بنسبة)

(32%لكل ساعة2 Venison). بالإضافة إلى تقليل الوقت بنسبة (7%)وإنتاج كمية (60) قطعة من المجمعات النهائية وبالتالي تجميع (60)محرك لكل ساعة.

ABSTRACT:

This research uses operations research techniques to achieve optimal solution for the production plan in the factory. It uses the goal programming method due to its ability in solving real problems by considering different goals at the same time instead of one goal to achieve optimality by using four different objective functions namely maximization of profit quantity and minimizing of cost and time of operation of the five different assemblies (Front end shield assembly, Rear-end shield assembly, stator assembly, rotor assembly and board swatch assembly), that make the final assembly of the motor. It used the software package (Win QSB Version 2) to obtain the optimal solution. The optimal solution maximizes profit by (1351) ID, minimizes cost by (32%) , minimizes production time by (7%) and increases production by (60) units.

Keywords: Operation Research, Linear Programming, Goal Programming, Objectives Constraints.

The goal of the research:

The aim of this research is to maximize the revenues of the product of the air cooled engine by reducing the cost and time in the production line of the air cooled engine in the General Company for Electrical Industries by applying the method of target programming and employing the ready- Win QSB, Version2)

Research Methodology

The reality of the production of air-cooled engine (HP) In the General Company for Electrical Industries and assembly necessary for all parts of the data engine (front cover complex, the back cover complex, router complex, Alstir complex, complex panel connectors (board)) for all production processes on different machines and through the special time, cost, energy production and design data collection For each part, these data were analyzed and used in the application of multi-purpose programming method to reach the optimal solution for loading production lines

The theoretical side

Introduction:

The process of decision making is one of the most important things in any industrial or service establishment, which may be adopted by adopting the subjective experience of the decision maker, but with the development of technology proved the failure of some of these decisions because of the avoidance of the optimal solution to

many of the problems and emerged the need for decisions right and fast, Its inability and lack of accuracy by changing some of the elements of the problem, which is characteristic of the industrial environment at present .

That operational research methods [Operations Research] Are widely used in decision-making assistance, where they seek to improve decision-making by providing a range of alternatives and selecting the best alternative. The decision maker has one or more goals he seeks to achieve. These goals are often contradictory and contradictory, on the one hand, as well as being bound by certain restrictions that cannot be bypassed by another. [Confident 2007].

Search History

The subject of multi - target optimization (or multiple decision - making goals) of important topics and harm taking space and wide - ranging in many areas (industrial, commercial and economic .. .. etc.), and that was the beginnings of this topic in 1951 , Where [Kuhn & Tucker] Published the first proposal on the problems of achieving multi-purpose optimization using the concept of optimization vector [Kuhn & Tuker 1951] As found in the works of Charnes & Copper 1961) The beginnings of programming linear goals, which seek to find a way to solve the problem of linear programming is not possible solution, which arise from interactions of source constraints or goals.

He (Sartoris & Spull 1974) Using one of the methods to achieve multi-goal optimization (target programming) Goal Programming) In the area of administrative

and financial planning, by applying the current decision model for one period, which included two objectives, namely, maximizing cash flow and profit.

Researchers (Jimenes et al 2006), the research included how to use the best methods to solve the problem of flexible multi-objective linear programming with the presence of blurry parameters to give the best solutions satisfactory to the decision maker.

The researchers used Stephen & Lungn 2007) In the application of the objective programming method in the process of planning the production of perishable products through the construction of a model, the production planning process consists of two stages and the division of each production process to the stages to reach a balanced level of production OK for all goals The researchers Famuyihla et al 2008) Based on a model based on objective programming, foggy logic to make a decision to analyze the checks and inaccuracies of the self-information that are consistent with the harmony or consistency of the active processors available during the early formation of the strategic partnership. The two researchers Oscan and Tokiu 2009) In their study using two models for the objective programming and blurry objective programming to decide the problem of balancing productive assembly lines on both sides of large products such as trucks and buses. The model included two objectives:

Reduce the number of mixed stations and reduce the time to complete the product assembly at each station. The proposed programmatic model is the first criterion in the decision making industry to solve the problem of balancing assembly

lines on both sides and multiple objectives. The researchers focused Pal et al) On the use of target programming in the planning of production of seasonal agricultural crops through the development of goals and constraints and build the model on the basis of the conversion of goals to the written formula and through the selection of goals and priorities, and was the best investment space and achieve a high profit by reducing costs.

The researchers Burcu & Metin 2011) In the use of a common concept for selecting devices through the use of a method F-PROMETHEE Which adopts a technique in evaluating multiple criteria in the selection of devices and using the results of this method as constraints in building the target programming model (A zero - one). The researchers proved successful in how the model was shared ZO GP with method F-PROMETHEE And use it to a real global application problem in solving the problem of selecting appliances. Developed by researcher Gang 2012) In using the ambiguous objective programming method based on the researcher model (Tiwari et al in 1987), In which the model of the collective model An additive Model)

The model proposed by the researcher to expand the model researcher (Tiwari) By adding the total negative weight weights between the desired degree of achievement and known objectives. The researcher has prepared the characteristics of the proposed model and its numerical application.

Targeted Programming Method GP) Goal Programming Method

Linear programming methods have addressed problems that have only one objective, but most decision situations do not have a single goal. Often, the decision maker has several primary and secondary goals that may complement one another or possibly conflict with each other. 2003 For example, the goal of raising the level and quality of service is contrary to the goal of reducing costs. Thus, the treatment of all the problems that each of them holds one goal shows a limited and non-comprehensive view and to put a solution to these problems on the assumption that the existence of one goal gives results inconsistent with the reality of the case [Majid 1999]. That's why a new sports style was developed in 2008 1952 which aims to address the problems of linear programming with multiple goals and called this method of multi-purpose programming (Goal Programming), Multi objective Programming Over time this method has developed to include problems of numerical programming and nonlinear programming.

As a result, this treatment came in line with the expectations of decision-makers in reaching a solution that achieves convergence in achieving the various goals. Thus, the method of programming goals deals with the issue of decision-making with a goal or set of goals, and show the effectiveness of the method of programming goals in cases where the objectives are conflicting . The development of such goals in the form of absolute constraints in the mathematical model may lead to the absence of a solution available to the issue No feasible Solution. As a result, some of these

goals must be incorporated into the objective function. The method of programming goals is useful for the decision-maker who accepts the convincing solution Satisfying Solution in the absence of the optimal solution Optimal Solution [Taha 2011].

The mechanism of using the objective programming is based on guiding the model towards selecting the values of the decision variables that give the least deviations (Deviations If we assume that we have a goal, Goal) There is certainly a value for deviations from this target gathered around it with a degree of flexibility (according to the constraints of the model) so that its values can be reduced in the direction that achieves the desired goal. Therefore, two kinds of deviations [Generous 2012]:

A - Positive Deviations: These are deviations whose values are higher than the value of the target and are also called higher deviations (Upper Deviations).

Negative Deviations: These are deviations whose values are less than the value of the target and are also called minimum deviations (Lower Deviations). In both cases, the objective programming method tends to reduce the values of these deviations (ie the goal will be reduced Minimization Deviations).

Definition of the objective programming method:

Objective programming is defined as representing the problem with a mathematical model that seeks to find the nearest and best solutions for pre-prepared values for a number of goals. In other words, the mathematical model for programming the goals aims at reducing the total deviations from the goals prepared

in advance to the lowest possible level. The programming of goals is expressed as a mathematical model that seeks to achieve several objectives within a specific decision environment. The decision environment defines the basic elements of the model, namely, decision variables and constraints. 2007].

Characteristics of the method of programming goals [Majid 1999, The Zeadi 2003]

Program programming features a number of features that give greater flexibility than linear programming:

1 - The possibility of programming goals in the treatment of decision - making problems with one or several goals or

The values of achieving the goals in a sequential manner (order) it is necessary to arrange goals according to preference (Importance) of decision - makers, and to be achieved sequentially according to the steps of the logical solution, so we can call on the programming of the goals of linear programming Almtzlsh (Sequential Linear Programming).

2 - Programming goals is a successful way of dealing with a situation of conflict or contradiction of multiple goals that cannot be fully accomplished using the linear programming method.

3 - Programming targets deviation variables [Deviation Variables] For each constraint imposed by the level of the target, and thus each constraint becomes equal.

4 - Programmatic programming includes two kinds of constraints

A - Limitations of targets containing positive deviation variables $_{U\ i}$ and negative deviation $_{V\ i}$ About the goal.

B - Real constraints (linear programming constraints) and are absolute goals [Absolute Objectives] whose failure to reach leads to an unacceptable solution.

5 - The process of achieving goals in a sequential way from the primary goals (absolute) to the goals of the lowest priority, and the process of determining the priorities or the relative importance of the goals are important in the formulation of the problem of programming goals, the error leads to an incorrect solution.

The general formula of the programming model of objectives [Zeyadi] 2003]

Min a = {P 1 (d 1 -, d 1 +), P 2 (d 2 -, d 2 +) ..... $^{P\ k\ (d\ k\text{-},\ d}$ k +)

Subject to:

$$\sum_{i=1}^{n} C_{ij}X_{ij} + d_i^- - d_i^+ = b_i \qquad j = 1,2,\ldots\ldots m$$

$$d_i^-, d_i^+ \geq 0 \qquad i = 1,2,\ldots\ldots n$$

As a n:

A = Represent the function of achievement, K = Number of goals, $_{X\ ij}$ = Decision variables, $_{b\ i}$ = Goal function value (I) In objective constraints, while in non-objective constraints, resources are available.

C_{ij} = Coefficient of variables, N = Number of variables, M = Number of entries, P_k = Goals,

d_i^- = Variable deviation indicating the lowest achievement of the target function I

d_i^+ = Variable deviation indicating the highest achievement of the target function I

Method of priority objectives Prioritized or Ranked Goal Method [Generous 2012]

For example, how does the company's management know that the importance of the goal of raising profits is twice as important as the goal of avoiding the use of extra time?

The best solution to this difficulty is to use the method of priority, ie priority, rather than weight, where the idea of this method depends on giving priority to the goal to a degree commensurate with the management's view of the importance of that goal. The objectives of the lowest degree of importance,

p_i) For each variance variable and so on P_1 Priority given to the most important goals and importance P_2 Then Next p_3 As in table 1).

Where the target function is:

$$\text{Minimize total divation} = p_1 (d_1^-) + p_2 (d_2^-) + P_3 (d_3^+) + P_4 (d_4^-)$$

Priorities and goals [Karim 2012]:

After defining the four goals, they were differentiated by using the method of coupling where the importance of each goal is compared with all the other goals and the goal which shows the most number of times before the biggest signal ( ) Gets the highest priority and so on for the rest of the goals.

Example: Let's have goals G1, G2, G3, G4)

Note through the previous law of combinations (6) Comparisons between four goals

Note that G1 the more visible in the left side of the recesses, the first priority is taken G2 It takes the second priority and so on for the rest of the goals.

About the General Company for Electrical Industries:

The General Company for Electrical Industries 17 / 8 / 1965 Production began on April 1 1967 It includes three laboratories:

1 - Air cooled laboratory: It is a specialized laboratory to produce single phase motors for evaporative air coolers and capacity of [a horse , a horse , HP] with distinction from US company Winchester.

2 - Fans factory: It is a collective plant for vertical and vertical fans based on parts manufactured from the main factory in the company and contains programmed turning machines and other machines to operate some parts of the fans.

3 - Engine Air Conditioner (Window type) 2 Ton: In addition to manufacturing air conditioner exchangers, industrial molds, caravans, repairing industrial motors, installing & maintaining air conditioners & generators according to special requests & designs, rehabilitation of high voltage motors, power transformers & electrical distribution.

Practical side:

The practical side of the research was carried out in the engine production plant - for the General Company for Electrical Industries - Baghdad and it was as follows:

-1 Choose the engine air chilled product (HP) Factory in the company consists of five front cover complex complexes, the back cover complex, complex router, Alstir complex and complex connectivity panel (Board) and each consists of a number of production processes and as shown in the technological track in Figure 1)

2 Extract data and information on the time and quantities of production, design capacity and costs per A complex of the company, in coordination with the Technical Department - Technology Division, as shown in table 2)

1- Target function.

1- The first goal ($_{Z1}$) Is to maximize the integration of complexes

$$Max.Z_1 = \sum_{i=a}^{e} P_i \sum X_{ij} = P_a \sum X_{aj} + P_b \sum X_{bj} + P_c \sum X_{cj} + P_d \sum X_{dj} + P_e \sum X_{ej}$$

2- The second objective ($_{z\,2}$) Is to reduce the time to get the job done to a minimum.

$$Max.Z_2 = \sum_{i=a}^{e} t_i \sum X_{ij} = t_a \sum X_{aj} + t_b \sum X_{bj} + t_c \sum X_{cj} + t_d \sum X_{dj} + t_e \sum X_{ej}$$

3- Third Objective $_{Z3}$) The cost of the products is minimized.

$$Max.Z_3 = \sum_{i=a}^{e} c_i \sum X_{ij} = c_a \sum X_{aj} + c_b \sum X_{bj} + c_c \sum X_{cj} + c_d \sum X_{dj} + c_e \sum X_{ej}$$

4- Goal 4 $_{Z\,4}$) Is to achieve the monthly plan for each part of the complexes (repeatability for each part) of the product to the minimum and not exceed the upper limit of the plan.

$$Max.Z_4 = \sum_{i=a}^{e} x_i = \sum X_{aj} + \sum X_{bj} + \sum X_{cj} + \sum X_{dj} + \sum X_{ej}$$

$$x_a \leq 60, x_b \leq 60, x_c \leq 80, x_d \leq 8, x_e \leq 100$$

C. Objective constraints

First: - Time constraint for pools (second)

$$\sum_{i=1}^{h} \sum_{j=1}^{h} x_{ij} \leq t_i$$

1- In time for the front cover assembly.

$$t_1x_1 + t_2x_2 + t_3x_3 + t_4x_4 + t_5x_5 + t_6x_6 + t_7x_7 \leq 244$$
$$157x_1 + 0x_2 + 15x_3 + 12x_4 + 15x_5 + 10x_6 + 8x_7 \leq 244$$
$$t_1 \leq 157, t_2 = 0, t_3 \leq 15, t_4 \leq 12, t_5 \leq 15, t_6 \leq 10, t_7 \leq 8$$

2- Time constraint for rear covers assembly.

$$t_8x_8 + t_9x_9 + t_{10}x_{10} + t_{11}x_{11} + t_{12}x_{12} + t_{13}x_{13} + t_{14}x_{15} + t_{15}x_{15} \leq 244$$

$$157x_8 + 0x_9 + 15x_{10} + 12x_{11} + 15x_{12} + 10x_{13} + 0x_{14} + 8x_{15} \leq 244$$

$$t_8 \leq 157, t_9 = 0, t_{10} \leq 15, t_{11} \leq 12, t_{12} \leq 15, t_{13} \leq 10, t_{14} = 0, t_{15} \leq 8$$

3- Time constraint for the router assembly

$$t_{16}x_{16} + t_{17}x_{17} + t_{18}x_{18} \leq 439$$

$$115x_{16} + 108x_{17} + 10x_{18} \leq 439$$

$$t_{16} \leq 115, t_{17} \leq 108 , t_{18} \leq 10$$

4- In time for the sitter complex

$$t_{19}x_{19} + t_{20}x_{20} + t_{21}x_{21} + t_{22}x_{22} + t_{23}x_{23} + t_{24}x_{24} + t_{25}x_{25} + t_{26}x_{26} + t_{27}x_{27} + t_{28}x_{28} +$$

$$t_{29}x_{29} + t_{30}x_{30} + t_{31}x_{31} \leq 637$$

$$t_{19} \leq 160, t_{20} \leq 30 , t_{21} \leq 45 , t_{22} \leq 80 , t_{23} \leq 15 , t_{24} \leq 15, t_{25} \leq 15, t_{26} \leq 15$$

$$t_{27} = 0, t_{28} \leq 60 , t_{29} \leq 60 , t_{30} \leq 72 , t_{31} \leq 15$$

$$160x_{19} + 30x_{20} + 45x_{21} + 80x_{22} + 15x_{23} + 15x_{24} + 15x_{25} + 15x_{26} + 0x_{27} + 60x_{28} + 60x_{29}$$

$$72x_{30} + 15x_{31} \leq 637$$

5- In time for the board assembly

$$t_{32}x_{32} + t_{33}x_{33} + t_{34}x_{34} \leq 45$$

$$t_{32} \leq 15, t_{33} \leq 10, t_{34} = 0$$

$$15x_{32} + 10x_{33} + 0x_{34} \leq 45$$

(D) The lack of salinity

E - After it has been Building a final form and convert it to restrictions, it was ready to use a computer program (Win QSB) Where preliminary results were found as shown below.

Solution

Goal 1: (Max.) = 1,351.24

Goal 2: (Min.) = 1,501.75

Goal 3: (Min.) = 14,132.52

Goal 4: (Max.) = 59.13

Conclusions

1 - The first goal has been achieved, but the profit is less than the company 's profit,

because the company 's profit due to engine chilled air (HP) Is (3000) Iraqi Dinar, either plan according to the model programming goal refers to gain a profit up to (1351) Iraqi Dinar .

2 - The second objective was achieved by exploiting the time of operation of the plant machinery time period (1501) And save an abundance of time by (108 (Second) 1.8) Minutes per hour worked, when using the target programming model.

3 - While the third objective was achieved according to the model of the target program by reducing the cost of the product by (14132) Iraqi Dinar.

4 - With regard to the fourth goal, the amount of new production using programming goals in the (60) Engine is the same hour as the company's plan (60) Engine per hour.

5 - The coexistence with the problems under study and depth in detail in a field and the consultation of specialists and experienced leads to the result of the correct analysis of any problem and then access to the best scientific method used to solve those problems.

6 - The effectiveness of programming goals in the field of production planning for the product of the air cooled engine lies in its ability to achieve more than one goal, and therefore the results obtained in the application of the method is more in line with the reality of the case.

Recommendations:

1 - Using modern scientific methods in operations research such as multi-goal linear programming in different fields (Administration, maintenance, marketing, production planning, cost calculations).

2 - Because of the consumption of machinery, which leads to the interruption or delay of the production process, we propose to the management of the company to replace

the machines consumed and influential in the process of production with modern machines to obtain the required production capacity and high efficiency.

3 - The use of scientific and technological methods in the planning of production in the company instead of the traditional methods because of their scientific possibilities is considered in the control of the production process.

4 - Through the mathematical model, the quantity of products, time and cost can be determined scientifically and accurately.

5 - The possibility of using (the target programming model) to obtain the optimal solutions for other products in the company.

The mathematical model of goal programming:

2- The **definition** of **variables.**

T	Variable icon	the details
1	Z_1	The first objective function
2	Z_2	The second target function
3	Z_3	The third objective function
4	Z_4	The fourth objective function
5	X_I	Number of Producing Complexes I = a, b, c, d, e For the parts that are included in the price
6	P_I	The price of the parts in the producing

		complexes I = 1,2,3, ... .34
7	t_i	The time it takes to produce the parts in the producing complexes I = 1,2,3, ... .34
8	C_i	Cost for parts of producing complexes I = 1,2,3, ... .34
9	X_a	Front cover assembly
10	X_b	Compound back cover
11	X_c	Router Complex
12	X_d	The Collector Complex
13	X_e	Assembly board
14	X_1	Repeat the front cover in the front cover assembly
15	X_2	Repeat the bearings in the front cover
16	X_3	Repeat the felds
17	X_4	Repeat the lid cover
18	X_5	Repeat the ferrous ring
19	X_6	Repeat the protective front cover of the dust
20	X_7	Repeating shock absorber

21	X 8	Repeat the back cover in the back cover assembly
22	X 9	Repeat the bearings for the back cover
23	X 10	Repeat the Bad
24	X 11	Repeat the back cover of the bearings cover
25	X 12	Repeat the iron ring
26	X 13	Repeat the protective back cover of the dust
27	X 14	Repeat the Viper
28	X 15	Repeated shock absorber
29	X 16	Repeat the rotor plate in the rotor assembly compound
30	X 17	Repeat the axis
31	X 18	Repeat the iron bush
32	X 19	Repeat the hard plate sheets in the hard part assembly
33	X 20	Repeat the iron bar
34	X 21	Duplicate Insulation
35	X 22	Repeated Insulation

36	X 23	Repeat the yellow wire (wire)
37	X 24	Repeated wavir (wire) red
38	X 25	Repeated wavir (wire) black
39	X 26	The frequency of the wire
40	X 27	Repeated sheets of fixed connector
41	X 28	Repeat the number of plastic pipes
42	X 29	Repeat the ligament
43	X 30	Duplicate structure
44	X 31	Repeated rubber bandages
45	X 32	Replicate the plugboard in the connector board assembly
46	X 33	Repeating connectors for the connection board
47	X 34	Repeat the number of small plaques of the plank assembly

Table (1) Priorities

T	Objectives	priority
1	Reach at least a certain amount of profit ($^{d1-}$)	P 1

2	Access to a certain level of production d_2^-)	P 2
3	Avoid using extra time (d_3^+)	P 3
4	Full use of working hours d_4^-)	P 4

Table (2) Shows the **cost per unit output of each part of** the **five complexes with** the **time required to produce one unit as well as repeating parts and prices in** the **complexes [** the **company].**

Parts	Cost (JD)	Time (seconds)	Repeating the parts in the complexes (hour)	Price (JD)
1	1635	157	1	209.97
2	500	0	1	64.21
3	33	15	1	4.24
4	4	12	1	0.51
5	5	15	1	0.64
6	9	10	1	1.16
7	150	8	1	19.26

8	1562	157	1	206.89
9	500	0	1	66.23
10	33	15	1	4.37
11	4	12	1	0.53
12	5	15	1	0.66
13	2	10	1	1.19
14	0	0	1	0. 26
15	150	8	1	19.87
16	4315	115	46	344.53
17	1051	108	1	83.92
18	270	10	2	21.55
19	8736	160	46	711.40
20	11	30	4	0.90
21	200	45	36	16.29
22	4	80	36	0.53
23	60	15	1	4.89
24	50	15	1	4.07
25	64	15	1	5.21

26	20	15	1	5.21
27	20	0	4	1.63
28	24	60	2	1.95
29	50	60	10	4.07
30	424	72	1	34.53
31	99	15	1	8.06
32	5oo	15	1	24.85
33	2	10	2	0.10
34	1	0	2	0.05

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