Journal of Economics
and Administrative Sciences (JEAS)

Available online at http://jeasiq.uobaghdad.edu.iq

Designing a Quality System using the Goals Programming Method -An Applied Research

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Received:9/2/2021 Accepted:23/2/2021 Published: March/ 2021

Abstract:

Due to the continuous development in society and the multiplicity of customers' desires and their keeping pace with this development and their search for the quality and durability of the commodity that provides them with the best performance and that meets their needs and desires, all this has led to the consideration of quality as one of the competitive advantages that many industrial companies compete for and which are of interest to customers and are looking for. The research problem showed that the Diyala State Company for Electrical Industries relies on some simple methods and personal experience to monitor the quality of products and does not adopt scientific methods and modern programs. The aim of this research is to design a system to monitor the production quality of the transformer (400/11 KVA) through the use of a method that helps to make decisions of a quantitative multi-objective nature, which is the method of lexicographic goal programming that the researcher used to integrate the preferences of the decision-maker in monitoring the quality of the production of the transformer (400/11 KVA). Using the two programs (Excel and Lingo) in constructing and solving the mathematical model that was applied in the sections (outer and inner iron core, winding and isolating, final assembly and quality control). The results obtained were efficient, as they achieved the least possible deviations from all the target values for all goals, which were determined by the decision-maker for each department.

Key words: **quality, quality control, Lexicographic goal programming.**

1. Introduction

The twentieth century was marked by important transformations that led to the era of globalization that we are living in today, and in light of these and other factors, organizations gave greater attention to quality with the beginning of the twentieth century, where quality became a remarkable organizational dimension due to the increase in the development of administrative thought in organizations and the expansion of markets with an increase The intensity of competition between them, the large size of the organizations, and the increase in their products in quantity and quality. After this dimension did not exceed an examination section affiliated with the production department in the organizations, it expanded until it reached the quality control function that is independent of the production function in the organization. Also, the quality of the product has become seen in all the stages it goes through, using scientific methods that help the decision-making process.

The Japanese were the first to care about the quality of their industries and products. After their products were described as inferior products, and this after World War II, now the Japanese industry represents high quality and reasonable price.

The transformations and developments that have occurred and which most economic institutions have known with their different specialties over the past years in terms of the diversity of their branches, products, interests and customers and their large size in addition to the fact that their operations are becoming more complex and their internal and external links have become many in raising the degree of responsibility, as well as the decision-making activity has become more complex at the level. Operational, as it has become one of the major challenges for decision-makers, and this is evident through the ambiguous circumstances and risks surrounding the decision-maker's activity and the economic conditions in the market.

Also, organizations have become relying on improving their production on economic programs within the activity of operations research, which depends on the scientific method in economic problems, and among these approved programs is programming goals that are considered a scientific method on which the decision-maker relies on determining his important decisions to operate the production and distribution processes. Goal programming is characterized by taking a set of preferences for a number of goals to obtain the best possible solution.

The researcher conducted a field survey on the (Diyala State Company for Electrical Industries) and found that the company is concerned with the quality of its products, but despite this interest there were complaints about the products due to malfunctions occurring in the product (the transformer 400/11 KVA that is produced in the distribution transformers laboratory in the Diyala State Company for Industries) Electrical), because the company uses personal experience and simple methods of quality control and does not use modern and sophisticated mathematical methods to control quality.

The aim of this research is to design a system for controlling the quality of industrial products in the distribution transformer laboratory of the Diyala State Company for Electrical Industries through the use of a method that helps to make decisions of a quantitative multi-objective nature. Through this study, it was proposed to formulate a multi-purpose mathematical model in the field of production quality control. The transformed 400/11 KVA, this new model allows us to integrate the preferences of the decision maker in case the goals took the values that they express in a certain period, whereas a lexicographic goal programming model was used to build a method for designing a system for controlling the quality of industrial products in the distribution transformers Laboratory of Diyala General Company for Electrical Industries which supports the processing of information for the levels of ambition in relation to the limitations of the goals and help the decision maker to search for the solution that achieves the highest degree of his preferences.

The importance of research or study for the company, given that through this study an efficient system can be developed to monitor the quality of products in the company through a multi-purpose mathematical model, the results of which were found using solid computer programs, where it is possible to apply this system to the rest of the company's products to monitor the quality of its products. The decision maker will find new results in record time if any new changes occur in the mathematical model inputs.

To search spatial, temporal and human boundaries, and as follows:

1) Spatial boundaries: The (Diyala State Company for Electrical Industries), which is located in Diyala Governorate, was chosen. The site includes the distribution transformer factories, the power transformer laboratory, the electrical and electronic metering laboratory, the optical cable plant, and laboratories that have stopped working due to the lack of economic viability of their production, which are (ceiling fans, candles Mug, steam iron).

2) Temporal limits: The research period extended from (3/1/2019) to (25/7/2020).

3) Human boundaries: Human borders are represented by the personal interviews that the researcher conducted with department managers in Diyala State Company for Electrical Industries and the engineers of the Distribution Transformers Laboratory.

4) Objective limits: The objective limits are represented by the main variables of the research and their sub-dimensions.

2. Research methodology:

2.1 Research Community and Sample:

The 400\11 KVA transformer that the distribution transformers Laboratory in Diyala State Company for Electrical Industries manufactures was chosen as a sample for research from a community that includes the remaining types of distribution transformers.

2.2 Justifications for choosing the research sample:

1. Due to the continuous high demand for the 400/11 KVA transformer.
2. The company has continued, since its inception, to manufacture the 400\11 KVA transformer.
3. The company undertakes the development of its product to obtain a quality product.

2.3 Research tools and methods:

1) The tools and equations for programming with the Lexicographic goal programming were used to design a quality control system, which included building models for the sections of the transformer, manufacturing them, and solving their equations using programs (Excel, Lingo) to obtain the results.
2) Methods of data collection: many methods have been used to collect data, the most prominent of which are:
a. Books, research and scientific references.
b. Personal interviews.
c. Information and data related to the transferor.
d. The internet.

3. Goal programming

3.1 The concept of goal programming:

Important economic developments in the areas of management and planning indicate that organizations and society have become divided into groups with multiple interests and values that do not have one specific goal, so it is important for the main goal of any decision problem to achieve a balance between interests when the goals are multiple and conflicting for the departments of the organization. (Abdel-Hamid, 2009: 189) Objective programming is an extended case of linear programming, as it is capable of solving problems with conflicting goals and constraints of different measurement units ... etc. (Kazem, 2006: 258)

Where goal programming is considered among the most important quantitative methods used in making decisions and rationalizing them. Programming by goals is an extension of linear programming, so that its model is formulated by specifying the goals to be achieved and the goal is expressed by a constraint called the target constraint. Cooper, Charnes) in 1955, and in 1961 the scientist Cooper formulated the model for programming objectives in its standard form for the first time, and in 1998 (B, Aouni) showed that the use of programming with objectives has a feature that distinguishes it from other models, which is that the values of x_i are a domain to which they belong (Salehi, 2019: 94)

As a result, the objectives programming model was developed to address the problems of multi-purpose decisions after setting them in a manner that shows the priority of each goal and then starting to achieve the main goals of absolute priority, followed by achieving the rest of the goals

Sub-level to the level that does not affect the goal of absolute priority, and we stop at the point beyond which we do not expect to obtain an improvement in the value of those conflicting goals. (Al-Salami, 2019: 112)

Where programming appeared with goals in 1952 at the hands of specialists Ferguson - Cooper in organizing the wages of workers, taking into account several goals, including:

(Business responsibility - service value - standard of living - incentives - enterprise development - level of experience and gender of the worker).

(M.Tomiz& D. Jones, 1998: 579) defined it as a mathematical method that tends to be flexible and realistic in solving complex decision problems, which takes into account several goals and many variables and restrictions.

As for B. Aouni, 1998: 37), he defined it as a model that takes into account several goals at once within the framework of testing the best solution from among the possible solutions. (Sang M. Lee, 1999: 8) believes that the objective programming model is one of the operating methods The first scientific to solve decision issues with multiple goals.

He defined it (Habib, 2015: 4) as the representation of the problem with a mathematical model that seeks to find the closest and best solutions to the predetermined values of a number of goals, in other words, the mathematical model for programming goals aims to reduce the total deviations from the predetermined goals to the minimum possible. Programming objectives is expressed as a mathematical model that seeks to achieve several goals within a specific decision environment. The decision environment defines the basic elements of the model, which are the decision variables, constraints, and the goal function.

Through the previous definitions, goal programming can be defined as one of the most important quantitative methods that help in decision-making and rationalize it, as it addresses multi-purpose problems by finding efficient solutions to them.

The use of the objective programming method is based on directing the model on choosing the values for the decision variables that give fewer deviations towards the goal. In the direction that achieves the desired goal, there are two types of deviations: (Attia, 2020: 221-222)

Positive deviations: They are the deviations whose values are higher than the target value and are also called upper deviation values.

Negative deviations: They are the deviations whose values are less than the value of the deviation, and it is also called the minimum values (Deviation Lower).

3.2 The importance of goal programming:

Programming goals is one of the most important methods that are used in administrative and scientific decision-making, which are based on achieving a set of goals or sometimes to achieve one goal. It can be said that the goals programming model has some characteristics as follows: (Attia, 2020: 222)

1. The goal programming model seeks to reduce the deviations between the achieved and targeted goals to a minimum that may reach zero.

2. The goal programming model seeks to express goals in the form of priorities and ranks.

3.3 Formulating the objectives programming model:

The decision-maker begins by defining the problem and then sets priorities for it, which all share in reaching the solution of the model, and this requires following important steps arranged, including:

- **Set goals accurately and clearly.**
- **Set the target value for these goals.**
- **Putting the goals in the form of a mathematical equation representing a constraint that includes the positive and negative deviation.**
- **Reducing the objective function equation containing deviations.**
- **The first group maximizing profit or reducing costs, risks, or working hours.**
- **The second group includes goals, which can be raw materials, work hours or a budget.**
- **The third group includes the restrictions and the condition of non-negativity, and we can express the general model as follows:**

(Muhammad, 2015: 48-49)

$$MinZ = \sum_{m=1}^{n} (\delta_i^+ + \delta_i^-) + \sum_{m=1}^{n} \delta_i^+ + \sum_{m=1}^{n} \delta_i^-$$
$$f(x_i) - \delta_i^+ + \delta_i^- = g_i$$
$$f(x_i) - \delta_i^+ + \delta_i^- = g_i$$
$$f(x_i) - \delta_i^+ + \delta_i^- = g_i$$
$$Cx_i \le b_i$$
$$x_i \ge 0$$
$$\delta_i^+, \delta_i^- \ge 0$$

whereas :

Z = represents the objective function.

δi ^ + = represent the positive deviations of the targets.

δi ^ - = represent negative deviations of targets.

gi = the target to be automatically reached for the i goal.

〖Cx〗 _i = Matrix of coefficients related to model constraints.

bi = represents available resources.

4. Designing a quality control system using the objectives programming method:

The method programming was used to design a quality control system and help the decision-maker to search for the solution that achieves the highest degree of satisfaction for the decision maker.

Where the quality control system was designed on the 400/11 KVA transformer and for certain sections due to the importance of these sections and because it has a great impact on the work of the transformer and these sections are (winding and insulation section, iron heart section, final assembly section, inspection section (quality control)) and will be addressed in detail For the process of designing a quality control system for the winding and isolating section using the method of lexicographic goal programming, while for the rest of the sections, the final results will be discussed only to ensure non-repetition and for

shortness, noting that the same steps were applied that were applied to the winding and isolation section.

4.1 Construction of a multi-objectives mathematical model for the 400/11 KVA transformer in the winding and insulation section:

The periods specified for the target restrictions are divided, as in the tables (1,2,3):

Table (1): Production process inputs, permissible limits and unit of measurement

Measuring unit	Allowed limits	Inputs to the production process	x_i
Kg	5.25	Pressboard for electrical purpose (R114)	x_1
Kg	0.71	Pressboard for electrical purpose (R115)	x_2
Kg	6	Pressboard for electrical purpose (R117)	x_3
Kg	0.315	Pressboard for electrical purpose (R124)	x_4
Kg	1.208	Coil Insulrrating Papers (R125)	x_5
Kg	3.39	Varnished Paper (R128\B)	x_6
Kg	12.23	Varnished Paper (R129\B)	x_7
Rool	1.37	Binylon Tape (R134)	x_8
Kg	116.45	Copper Strip (R144\A)	x_9
Kg	154.45	PVF Copper Wire (R162\B)	x_{10}
Kg	0.396	Paste (C515)	x_{11}
Rool	0.5	Pressure Sensitive Adhesive Polyester Tape (C520)	x_{12}
Rool	2.14	Pressure Sensitive Adhesive Polyester Tape (C522)	x_{13}
Kg	0.01	Resin Flux Cord Solder (P608)	x_{14}
Pcs	434	Wooden Duct (P569)	x_{15}
Pcs	9	Wooden Duct (P579)	x_{16}

Table (2): Production process variables, permissible limits and unit of measurement

measuring unit	Allowed limits	Inputs to the production process	s_i
Mm	148-142	Width of inner hole of coil (A)	s_1
Mm	259-254	Coil Inner Slot Length (B)	s_2
Mm	280-275	File width (C)	s_3
Mm	492-484	Coil length (D)	s_4
Mm	263-261	Coil Height (E)	s_5
Mm	7-2	Coil resistance to temperature	s_6

Table (3): Outputs of the production process, its permissible limits, and the unit of measurement

measuring unit	Allowed limits	Outputs of the production process	y_i
Mm	146-144	Width of inner hole of coil after drying (A)	y_1
Mm	256-254	Length of inner hole of coil after drying (B)	y_2
Mm	278-274	Width of the coil after drying (C)	y_3
Mm	489-487	Coil length after drying (D)	y_4
Mm	263-261	Coil height after drying (E)	y_5

4.2 The desired goals of building a mathematical model for the winding and insulation section:

1.Keep the measurement of the width of the inner hole of the coil after drying within the permissible limits.
2.Keep measuring the length of the inner hole of the coil after drying within permissible limits.
3.Keep measuring coil width after drying within permissible limits.
4.Keep measuring the length of the coil after drying within permissible limits.
5.Keep the coil height measurement after drying within permissible limits.
6.Maintain dimensions and coil resistance within permissible limits.

Assuming that:

- **xi is the input to the production process.**
- **si are the process parameters.**
- **yi is the output of the production process.**

In order to formulate this problem in the form of the objectives programming model, we follow the following steps:

1.<u>We make a change in the shape of the goal and limitations:</u>

We convert the level of ambition for each goal and constraint specified over a period into a goal and constraint which is an inequality where its second limb is the upper limit, for example: s1∈ [148-142] after the change s1 ^ '= s1-142≤6

So all the variables are specified by one side, that is, every goal and constraint is an inequality or an equation.

$x_1 = 5.25 \rightarrow x'_1 = 5.25$
$x_2 = 0.71 \rightarrow x'_2 = 0.71$
$x_3 = 6 \rightarrow x'_3 = 6$
$x_4 = 0.31 \rightarrow x'_4 = 0.315$
$x_5 = 1.208 \rightarrow x'_5 = 1.208$
$x_6 = 3.39 \rightarrow x'_6 = 3.39$
$x_7 = 12.23 \rightarrow x'_7 = 12.23$
$x_8 = 1.37 \rightarrow x'_8 = 1.37$
$x_9 = 116.45 \rightarrow x'_9 = 116.45$
$x_{10} = 154.45 \rightarrow x'_{10} = 154.45$
$x_{11} = 0.396 \rightarrow x'_{11} = 0.396$
$x_{12} = 0.5 \rightarrow x'_{12} = 0.5$
$x_{13} = 2.14 \rightarrow x'_{13} = 2.14$
$x_{14} = 0.01 \rightarrow x'_{14} = 0.01$
$x_{15} = 434 \rightarrow x'_{15} = 434$
$x_{16} = 9 \rightarrow x'_{16} = 9$
$s_1 \in [148 - 142] \rightarrow s'_1 = s_1 - 142 \leq 6 \rightarrow s'_1 \leq 6$
$s_2 \in [259 - 254] \rightarrow s'_2 = s_2 - 254 \leq 5 \rightarrow s'_2 \leq 5$
$s_3 \in [280 - 275] \rightarrow s'_3 = s_3 - 275 \leq 5 \rightarrow s'_3 \leq 5$
$s_4 \in [492 - 484] \rightarrow s'_4 = s_4 - 484 \leq 8 \rightarrow s'_4 \leq 8$
$s_5 \in [263 - 261] \rightarrow s'_5 = s_5 - 261 \leq 2 \rightarrow s'_5 \leq 2$
$s_6 \in [7 - 2] \rightarrow s'_6 = s_6 - 2 \leq 5 \rightarrow s'_6 \leq 5$
$y_1 \in [146 - 144] \rightarrow y'_1 = y_1 - 144 \leq 2 \rightarrow y'_1 \leq 2$
$y_2 \in [256 - 254] \rightarrow y'_2 = y_2 - 254 \leq 2 \rightarrow y'_2 \leq 2$
$y_3 \in [278 - 274] \rightarrow y'_3 = y_3 - 274 \leq 4 \rightarrow y'_3 \leq 4$
$y_4 \in [489 - 487] \rightarrow y'_4 = y_4 - 487 \leq 2 \rightarrow y'_4 \leq 2$
$y_5 \in [263 - 261] \rightarrow y'_5 = y_5 - 261 \leq 2 \rightarrow y'_5 \leq 2$

As for the regression equations, they are as follows:

$y_1 = a_1 + a_2^* s_1 + a_3^* s_2 + a_4^* s_3 + a_5^* s_4 + a_6^* s_5 + a_7^* s_6$
$y_2 = b_1 + b_2^* s_1 + b_3^* s_2 + b_4^* s_3 + b_5^* s_4 + b_6^* s_5 + b_7^* s_6$
$y_3 = c_1 + c_2^* s_1 + c_3^* s_2 + c_4^* s_3 + c_5^* s_4 + c_6^* s_5 + c_7^* s_6$
$y_4 = d_1 + d_2^* s_1 + d_3^* s_2 + d_4^* s_3 + d_5^* s_4 + d_6^* s_5 + d_7^* s_6$
$y_5 = e_1 + e_2^* s_1 + e_3^* s_2 + e_4^* s_3 + e_5^* s_4 + e_6^* s_5 + e_7^* s_6$

2.<u>Modification of the regression equations:</u>

After adjusting the aspiration levels, the regression equations become as follows:

$$\mathbf{y'_1 = a'_1 + a^*_2 s'_1 + a^*_3 s'_2 + a^*_4 s'_3 + a^*_5 s'_4 + a^*_6 s'_5 + a^*_7 s'_6}$$
$$\mathbf{y'_2 = b'_1 + b^*_2 s'_1 + b^*_3 s'_2 + b^*_4 s'_3 + b^*_5 s'_4 + b^*_6 s'_5 + b^*_7 s'_6}$$
$$\mathbf{y'_3 = c'_1 + c^*_2 s'_1 + c^*_3 s'_2 + c^*_4 s'_3 + c^*_5 s'_4 + c^*_6 s'_5 + c^*_7 s'_6}$$
$$\mathbf{y'_4 = d'_1 + d^*_2 s'_1 + d^*_3 s'_2 + d^*_4 s'_3 + d^*_5 s'_4 + d^*_6 s'_5 + d^*_7 s'_6}$$
$$\mathbf{y'_5 = e'_1 + e^*_2 s'_1 + e^*_3 s'_2 + e^*_4 s'_3 + e^*_5 s'_4 + e^*_6 s'_5 + e^*_7 s'_6}$$

<u>3- Determine the priority factors for each goal:</u>

$p_1 \rightarrow y_1$
$p_2 \rightarrow y_2$
$p_3 \rightarrow y_3$
$p_4 \rightarrow y_4$
$p_5 \rightarrow y_5$
$p_6 \rightarrow s_1 - s_6$

We define priority factors, where we attach each goal constraint with a priority factor in order to alleviate the severity of the problem to the problem of reducing the sum of deviations under the goals restrictions, while giving consideration to the goals with the highest priority factors.

4.3 <u>Formulation of the Lexicographic goal programming model</u>:

Accordingly, the multi-purpose mathematical model for the winding and insulation section is as follows:

$$Minz \sum_{m=1}^{11} = (\delta_m^+ + \delta_m^-)$$

S.to:

$$p_1: y'_1 - \delta_1^+ + \delta_1^- = 2$$
$$p_2: y'_2 - \delta_2^+ + \delta_2^- = 2$$
$$p_3: y'_3 - \delta_3^+ + \delta_3^- = 4$$
$$p_4: y'_4 - \delta_4^+ + \delta_4^- = 2$$
$$p_5: y'_5 - \delta_5^+ + \delta_5^- = 2$$
$$p_6: s'_1 - \delta_6^+ + \delta_6^- = 6$$
$$s'_2 - \delta_7^+ + \delta_7^- = 5$$
$$s'_3 - \delta_8^+ + \delta_8^- = 5$$
$$s'_4 - \delta_9^+ + \delta_9^- = 8$$
$$s'_5 - \delta_{10}^+ + \delta_{10}^- = 2$$
$$s'_6 - \delta_{11}^+ + \delta_{11}^- = 5$$
$$y'_1, y'_2, y'_3, y'_4, y'_5, s'_1, s'_2, s'_3, s'_4, s'_5, s'_6 \geq 0$$
$$\delta_i^+, \delta_i^- \geq 0 \quad (i = 1, \ldots, 11)$$

Where: p1, p2, p3, p4, p5, p6 are the priority coefficients

Using an excel program, we find the following regression equations:

$$y'_1 = 145.018 - 0.097^*S'_1 + 0.100^*S'_2 + 0.091^*S'_3 - 0.025^*S'_4 - 0.191^*S'_5 + 6.718^*S'_6$$

$$y'_2 = 2.786 + 0.006^*S'_1 + 0.023^*S'_2 - 0.008^*S'_3 + 0.012^*S'_4 - 0.026^*S'_5 - 0.026^*S'_6$$

$$y'_3 = 60.997 + 0.008^*S'_1 + 0.494^*S'_2 + 0.121^*S'_3 - 0.115^*S'_4 + 0.227^*S'_5 + 13.113^*S'_6$$

$$y'_4 = 465.327 + 0.005^*S'_1 + 0.042^*S'_2 + 0.082^*S'_3 - 0.023^*S'_4 + 0.149^*S'_5 - 10.405^*S'_6$$

$$y'_5 = 265.592 + 0.073^*S'_1 - 0.055^*S'_2 - 0.084^*S'_3 + 0.016^*S'_4 + 0.082^*S'_5 - 1.620^*S'_6$$

We substitute the regression equations into the mathematical model:

$$Min\, z = p_1(\delta_1^+) + p_2(\delta_2^+) + p_3(\delta_3^+) + p_4(\delta_4^+) + p_5(\delta_5^+) + p_6(\delta_6^+ + \delta_7^+ + \delta_8^+ + \delta_9^+ + \delta_{10}^+ + \delta_{11}^+)$$

S.to:

$$\delta_1^+ - \delta_1^- + 2 = y'_1 = 145.018 - 0.097^*S'_1 + 0.100^*S'_2 + 0.091^*S'_3 - 0.025^*S'_4 - 0.191^*S'_5 + 6.718^*S'_6$$

$$\delta_2^+ - \delta_2^- + 2 = y'_2 = 2.786 + 0.006^*S'_1 + 0.023^*S'_2 - 0.008^*S'_3 + 0.012^*S'_4 - 0.026^*S'_5 - 0.026^*S'_6$$

$$\delta_3^+ - \delta_3^- + 4 = y'_3 = 60.997 + 0.008^*S'_1 + 0.494^*S'_2 + 0.121^*S'_3 - 0.115^*S'_4 + 0.227^*S'_5 + 13.113^*S'_6$$

$$\delta_4^+ - \delta_4^- + 2 = y'_4 = 465.327 + 0.005^*S'_1 + 0.042^*S'_2 + 0.082^*S'_3 - 0.023^*S'_4 + 0.149^*S'_5 - 10.405^*S'_6$$

$$\delta_5^+ - \delta_5^- + 2 = y'_5 = 265.592 + 0.073^*S'_1 - 0.055^*S'_2 - 0.084^*S'_3 + 0.016^*S'_4 + 0.082^*S'_5 - 1.620^*S'_6$$

$$s'_1 - \delta_6^+ + \delta_6^- = 6$$

$$s'_2 - \delta_7^+ + \delta_7^- = 5$$

$$s'_3 - \delta_8^+ + \delta_8^- = 5$$

$$s'_4 - \delta_9^+ + \delta_9^- = 8$$

$$s'_5 - \delta_{10}^+ + \delta_{10}^- = 2$$

$$s'_6 - \delta_{11}^+ + \delta_{11}^- = 5$$

$$s'_1, s'_2, s'_3, s'_4, s'_5, s'_6 \geq 0$$

$$\delta_i^+, \delta_i^- \geq 0 \quad (i = 1, \dots, 11)$$

4.4 Solve the multi-objective mathematical model for the winding and insulation section using Lingo program:

The first goal:

$min\delta_1^+$

S.to:

$$-0.097^*S_1' + 0.100^*S_2' + 0.091^*S_3' - 0.025^*S_4' - 0.191^*S_5' + 6.718^*S_6' - \delta_1^+ + \delta_1^- = -143.018$$

$$0.006^*S_1' + 0.023^*S_2' - 0.008^*S_3' + 0.012^*S_4' - 0.026^*S_5' - 0.026^*S_6' - \delta_2^+ + \delta_2^- = -0.786$$

$$0.008^*S_1' + 0.494^*S_2' + 0.121^*S_3' - 0.115^*S_4' + 0.227^*S_5' + 13.113^*S_6' - \delta_3^+ + \delta_3^- = -56.997$$

$$0.005^*S_1' + 0.042^*S_2' + 0.082^*S_3' - 0.023^*S_4' + 0.149^*S_5' - 10.405^*S_6' - \delta_4^+ + \delta_4^- = -463.327$$

$$0.073^*S_1' - 0.055^*S_2' - 0.084^*S_3' + 0.016^*S_4' + 0.082^*S_5' - 1.620^*S_6' - \delta_5^+ + \delta_5^- = -263.592$$

$$s_1' - \delta_6^+ + \delta_6^- = 6$$
$$s_2' - \delta_7^+ + \delta_7^- = 5$$
$$s_3' - \delta_8^+ + \delta_8^- = 5$$
$$s_4' - \delta_9^+ + \delta_9^- = 8$$
$$s_5' - \delta_{10}^+ + \delta_{10}^- = 2$$
$$s_6' - \delta_{11}^+ + \delta_{11}^- = 5$$
$$s_1', s_2', s_3', s_4', s_5', s_6' \geq 0$$
$$\delta_i^+, \delta_i^- \geq 0 \quad (i = 1, \ldots, 11)$$

4.5 Results obtained by using Lingo program:

Table (4): The results obtained using the Lingo program, the first goal

Objective function	The original decision variables	Decision variables after the change	Negative deviations δ_i^-	Positive deviations δ_i^+
Z=0	$y_1 = 144$	$S_1' = 6$	2	0.000
	$y_2 = 254.631$	$S_2' = 5$	0.631	0.000
	$y_3 = 274$	$S_3' = 5$	4	0.000
	$y_4 = 487$	$S_4' = 8$	2	0.000
	$y_5 = 261$	$S_5' = 2$	2	0.000
	$s_1 = 148$	$S_6' = 0$	0.000	0.000
	$s_2 = 259$		0.000	0.000
	$s_3 = 280$		0.000	0.000
	$s_4 = 492$		0.000	0.000
	$s_5 = 263$		0.000	0.000
	$s_6 = 2$		5.000	0.000

$$y_1' - \delta_1^+ + \delta_1^- = 2 \rightarrow y_1' = 2 + \delta_1^+ - \delta_1^- = 2 + 0 - 2 = 0$$

$$\mathbf{y_1' = y_1 - 144 \rightarrow y_1 = y_1' + 144 = 0 + 144 = 144}$$
$$\mathbf{y_2' - \delta_2^+ + \delta_2^- = 2 \rightarrow y_2' = 2 + \delta_2^+ - \delta_2^- = 2 + 0 - 0.631 = 1.369}$$
$$\mathbf{y_2' = y_2 - 254 \rightarrow y_2 = y_2' + 254 = 0.631 + 254 = 254.631}$$
$$\mathbf{y_3' - \delta_3^+ + \delta_3^- = 4 \rightarrow y_3' = 4 + \delta_3^+ - \delta_3^- = 4 + 0 - 4 = 0}$$
$$\mathbf{y_3' = y_3 - 274 \rightarrow y_3 = y_3' + 274 = 0 + 274 = 274}$$
$$\mathbf{y_4' - \delta_4^+ + \delta_4^- = 2 \rightarrow y_4' = 2 + \delta_4^+ - \delta_4^- = 2 + 0 - 2 = 0}$$
$$\mathbf{y_4' = y_4 - 487 \rightarrow y_4 = y_4' + 487 = 0 + 487 = 487}$$
$$\mathbf{y_5' - \delta_5^+ + \delta_5^- = 2 \rightarrow y_5' = 2 + \delta_5^+ - \delta_5^- = 2 + 0 - 2 = 0}$$
$$\mathbf{y_5' = y_5 - 261 \rightarrow y_5 = y_5' + 261 = 0 + 261 = 261}$$
$$\mathbf{s_1' - \delta_6^+ + \delta_6^- = 6 \rightarrow s_1' = 6 + \delta_6^+ - \delta_6^- = 6 + 0 - 0 = 6}$$
$$\mathbf{S_1' = S_1 - 142 \rightarrow S_1 = S_1' + 142 = 6 + 142 = 148}$$
$$\mathbf{s_2' - \delta_7^+ + \delta_7^- = 5 \rightarrow s_2' = 5 + \delta_7^+ - \delta_7^- = 5 + 0 - 0 = 5}$$
$$\mathbf{S_2' = S_2 - 254 \rightarrow S_2 = S_2' + 254 = 5 + 254 = 259}$$
$$\mathbf{s_3' - \delta_8^+ + \delta_8^- = 5 \rightarrow s_3' = 5 + \delta_8^+ - \delta_8^- = 5 + 0 - 0 = 5}$$
$$\mathbf{s_3' = s_3 - 275 \rightarrow s_3 = s_3' + 275 = 5 + 275 = 280}$$
$$\mathbf{s_4' - \delta_9^+ + \delta_9^- = 8 \rightarrow s_4' = 8 + \delta_9^+ - \delta_9^- = 8 + 0 - 0 = 8}$$
$$\mathbf{s_4' = s_4 - 484 \rightarrow s_4 = s_4' + 484 = 8 + 484 = 492}$$
$$\mathbf{s_5' - \delta_{10}^+ + \delta_{10}^- = 2 \rightarrow s_5' = 2 + \delta_{10}^+ - \delta_{10}^- = 2 + 0 - 0 = 2}$$
$$\mathbf{s_5' = s_5 - 261 \rightarrow s_5 = s_5' + 261 = 2 + 261 = 263}$$
$$\mathbf{s_6' - \delta_{11}^+ + \delta_{11}^- = 5 \rightarrow s_6' = 5 + \delta_{11}^+ - \delta_{11}^- = 5 + 0 - 5 = 0}$$
$$\mathbf{s_6' = s_6 - 2 \rightarrow s_6 = s_6' + 2 = 0 + 2 = 2}$$

4.6 Discuss the results for the winding and insulation section

Through Table (5) we see that all results fall within the specified periods for each variable, where:

1) We note that the width of the internal aperture of the file after drying (A), which was referred to as (y1), which represents the first of the desired goals, as its value appeared after the monitoring process on it and by using programming model which is (144) as this value is acceptable because it falls within the period specified for it [146-144] and as shown in Table (5).

2) We note that the length of the internal aperture of the file after drying (B), which was referred to as (y2), which represents the second target of the desired goals, as its value appeared after the monitoring process on it and using programming model, which is (254.631) as this value is acceptable because it is within the period specified for it [256-254] and as shown in Table (5).

3) We note that the width of the file after drying (C), which was referred to as (y3), which represents the third goal of the desired goals, as its value appeared after the monitoring process on it and using programming model model, which is (274) as this value is acceptable and falls within the specified period for it [278-274] and as shown in Table (5).

4) We note that the length of the file after drying (D), which was referred to as (y4), which represents the fourth goal of the desired goals, as its value appeared after the monitoring process on it and using programming model, which is (487), as this value is acceptable because it falls within the specified period it has [489-487] and as shown in Table (5).

5) We note that the height of the file after drying (E), which was referred to as (y5), which represents the fifth of the desired goals, as its value appeared after the

monitoring process on it and by using programming model, which is (261) as this value is acceptable because it falls within the specified period it has [263-261] and as shown in Table (5).

6) We note that the width of the internal aperture of the file (A), which is referred to as (S1), which is considered within the sixth objective of the desired goals, as its value appeared after the monitoring process on it and by using programming model, which is (148) as this value is acceptable and falls within the specified period for it [148-142] and as shown in Table (5).

7) We note that the length of the internal slot of the file (B), which is referred to as (S2), which is considered within the sixth goal of the desired goals, as its value appeared after the monitoring process on it and using programming model, which is (259) as this value is acceptable and falls within the specified period for it [259-254] and as shown in Table (5).

8) We note that the width of the file (C), which has been referred to as (S3), which is considered within the sixth goal of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programmingmodel, which is (280) as this value is acceptable and falls within the specified period for it (280-275] and as shown in Table (5).

9) We note that the length of the file (D), which has been referred to as (S4), which is considered within the sixth goal of the desired goals, as its value appeared after the monitoring process on it and using programming model, which is (492) as this value is acceptable and falls within the specified period for it (492-484] and as shown in Table (5).

10) We note that the height of the file (E), which was referred to as (S5), which is considered within the sixth goal of the desired goals, as its value appeared after the monitoring process on it and using programming model, which is (263) as this value is acceptable and falls within the specified period. [263-262] and as shown in Table (5).

11) We note that the resistance of the file to the temperature, which is referred to as (S6), which is considered within the sixth objective of the desired goals, as its value appeared after the monitoring process on it and using programming model, which is (2) as this value is acceptable and falls within the specified period for it [7-2] and as shown in Table (5).

Table (5): Comparison of the final results, using the lexicographic goal programming with the specified periods

Results obtained using the Lingo program	Measuring unit	Allowed limits	Variables of the productive process	s_i
148	Mm	148-142	Width of inner hole of coil (A)	s_1
259	Mm	259-254	Coil Inner Slot Length (B)	s_2
280	Mm	280-275	File width (C)	s_3
492	Mm	492-484	Coil length (D)	s_4
263	Mm	263-261	Coil Height (E)	s_5
2	Mm	7-2	File resistance to temperature	s_6

-	measruing unit	Allowed limits	Outputs of the production process	y_i
144	Mm	146-144	Width of inner hole of coil after drying (A)	y_1
254.631	Mm	256-254	Length of inner hole of coil after drying (B)	y_2
274	Mm	278-274	Width of the coil after drying (C)	y_3
487	Mm	489-487	Coil length after drying (D)	y_4
261	Mm	263-261	Coil height after drying (E)	y_5

By finding the first goal of the multi-objectives mathematical model of the twisting and isolating section, the other objectives were achieved. Therefore, it is not necessary to solve the mathematical models for the other goals and be satisfied with the results achieved from solving the mathematical model for the first goal.

5. Discuss the results for the external iron heart section:

Through Table (6) we see that all results fall within the specified periods for each variable, where:

1. Notice that the non-load current of the ferrous core (the value of the current that the transformer draws when not loaded), which is referred to as (y1), which represents the first of the desired targets, as its value appeared after the monitoring process on it and using lexicographic goal programming model which is (4.03) where That this value is acceptable because it falls within the specified periods [4.03-1.03] and as shown in Table.(6)

2.We note that the non-bearing losses of the iron core (the iron losses occurring inside the iron core), which has been referred to as (y2), which represents the second of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model, which is (110) as this value Acceptable because it falls within the specified periods [187.77-110] and as shown in Table.(6)

3.We note that the net weight of the iron core, which was referred to as (y3), which represents the third of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model, which is (109.5) as this value is acceptable and falls within the specified period. [109.5] and as shown in Table (6).

4.We note that the width of the iron heart chip, which was referred to as (S1), which is considered within the fourth goal of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model, which is (240.5), as this value is acceptable and falls within the specified period for it [240.5-240] and as shown in Table.(6)

5.We note that the width of the inner opening of the iron heart, which is referred to as (S2), which is considered within the fourth goal of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model, which is (67) as this value is acceptable and falls within the specified period. [69-67] and as shown in Table (6).

6.We note that the length of the inner opening of the iron heart, which was referred to as (S3), which is considered within the fourth goal of the desired goals, as its value appeared after the monitoring process on it and lexicographic goal programming model, which is (272) as this value is acceptable and falls within the specified period. [272-268] and as shown in Table (6).

7.We note that the width of the iron core, which was referred to as (S4), which is considered within the fourth goal of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model, which is (409) as this value is acceptable and falls within the specified period for it [411- 409] and as shown in Table (6).

8.We note that the length of the iron core, which was referred to as (S5), which is considered within the fourth goal of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model, which is (207) as this value is acceptable and falls within the specified period for it [209- 207] and as shown in Table (6).

9.We note that the width of the distance between the inner aperture and the circumference of the iron heart, which is referred to as (S6), which is considered within the fourth goal of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model, which is (69) as this value is acceptable and falls within the period Specified for it [71-69] and as shown in Table.(6)

Table (6): Comparison of the final results using the lexicographic goal programming with the specified periods

Results obtained using Lingo program	measuring unit	The periods specified for it	Variables of the production process	s_i
240.5	Mm	240.5-240	(H) Slide Show	s_1
67	Mm	69-67	(E) Display internal aperture Iron Heart	s_2
272	Mm	272-268	(F) along the inner hole of the Iron Heart	s_3
409	Mm	411-409	(D) show Iron Heart	s_4
207	Mm	209-207	(C) the length of the Iron Heart	s_5
69	Mm	71-69	(G) display distance between the inner perimeter of the aperture and the Iron Heart	s_6
-	measuring unit	The periods specified for it	Outputs of the production process	y_i
4.03	V	4.03-1.03	No-load current to ferrous core (the value of current drawn by the transformer when no-load)	y_1
110	W	187.77-110	Non-ferrous losses to the ferrous core (ferrous losses occurring within the core)	y_2
109.5	Kg	109.5	The net weight of the iron core	y_3

By finding the first goal of the multi-objectives mathematical model of the external iron heartsection, the other objectives were achieved. Therefore, it is not necessary to solve the mathematical models for the other goals and be satisfied with the results achieved from solving the mathematical model for the first goal.

6. Discuss the findings for the Internal Iron Heart section:

1. We note that the non-load current of the ferrous core (the value of the current that the transformer draws when not loaded), which is referred to as (y1), which represents the first target of the desired targets, as its value appeared after the monitoring process on it and using lexicographic goal programming model which is (2.9399) as these The value is acceptable because it falls within the specified periods [4.03-1.4] and as shown in Table (7).

2. We note that the non-bearing losses of the iron core (the ferrous losses occurring inside the iron core), which was referred to as (y2), which represents the second goal of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model which is (217.15) as this value acceptable because it falls within the specified periods [217.15-125] and as shown in Table (7).

3. We note that the net weight of the iron heart, which was referred to as (y3), which represents the third of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model, which is (125.3) as this value is acceptable and falls within the specified period for it [125.3] And as shown in Table (7).

4. We note that the width of the iron heart chip, which was referred to as (S1), which is considered within the fourth goal of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model which is (240.5) as this value is acceptable and falls within the specified period for it (240.5) -240] and as shown in Table (7).

5. We note that the width of the inner opening of the iron heart, which is referred to as (S2), which is considered within the fourth goal of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model, which is (131) as this value is acceptable and falls within the specified period for it [133-131] and as shown in Table (7).

6. We note that the length of the inner opening of the iron heart, which was referred to as (S3), which is considered within the fourth goal of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model, which is (272) as this value is acceptable and falls within the specified period. [272-268] and as shown in Table (7).

7. We note that the width of the iron core, which was referred to as (S4), which is considered within the fourth goal of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model, which is (409) as this value is acceptable and falls within the specified period for it [411- 409] and as shown in Table (7).

8. We note that the length of the iron core, which was referred to as (S5), which is considered within the fourth goal of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model, which is (271) as this value is acceptable and falls within the specified period for it [273-271] and as shown in Table (7).

9. We note that the width of the distance between the inner aperture and the circumference of the iron heart, which is referred to as (S6), which is considered within the fourth goal of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model, which is (69) as this value is acceptable and falls within the period specified for it [71-69] and as shown in Table (7).

Table (7): Comparison of the final results using the lexicographic goal programming with the specified periods

Results obtained using Lingo program	measuring unit	The periods specified for it	Variables of the production process	s_i
240.5	Mm	240.5-240	(H) Slide width	s_1
131	Mm	133-131	(E) Width of the inner opening of the iron core	s_2
272	Mm	272-268	(F) The length of the inner opening of the iron core	s_3
411	Mm	411-409	(D) Iron core view	s_4
271	Mm	273-271	(C) The length of the iron core	s_5
69	Mm	71-69	(G) Width of the distance between the inner aperture and the circumference of the ferrous core	s_6
-	measuring unit	The periods specified for it	Outputs of the production process	y_i
2.9399	V	4.03-1.4	No-load current to ferrous core (the value of current drawn by the transformer when no-load)	y_1
217.15	W	217.15-125	Non-ferrous losses to the ferrous core (ferrous losses occurring within the core)	y_2
125.3	Kg	109.5	The net weight of the iron core	y_3

By finding the first goal of the multi-objectives mathematical model for the internal iron heart section, the other objectives were achieved. Therefore, it is not necessary to solve the mathematical models for the other goals and be satisfied with the results achieved from solving the mathematical model for the first goal.

7. Discuss the results for the final assembly section:

Through Table (8) we see that all results fall within the specified periods for each variable, where:

1.We note that the conversion ratio between files (knowing the shorts and the increase and decrease in the number of file turns) for tab. (1), which was referred to as (y1), which represents the first goal of the desired goals, where its value appeared after the monitoring process on it and using lexicographic goal programming model, which is (47.933) As this value is acceptable because it falls within the periods specified for it [48.317-47.933] and as shown in Table (8).
2.We note that the conversion ratio between files (knowing the shorts and the increase and decrease in the number of turns of the file) of tab. (2), which was referred to as (y2), which represents the second goal of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model which is (46.792) As this value is acceptable because it falls within the periods specified for it [47.167-46.792] and as shown in Table (8).
3.We note that the conversion ratio between files (knowing the shorts and the increase and decrease in the number of turns of the file) for Tab. (3), which was referred to as (y3), which represents the third goal of the desired goals, where its value appeared after the monitoring process on it and using lexicographic goal programming model, which is (45.650) As this value is acceptable and falls within the period specified for it [46.016-45.650] and as shown in Table (8).
4.We note that the conversion ratio between files (knowing the shorts and the increase and decrease in the number of turns of the file) for tab. (4), which was referred to as (y4), which represents the fourth goal of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model, which is (44.509) As this value is acceptable because it falls within the periods specified for it [44.866-44.509] and as shown in Table (8).
5.We note that the conversion ratio between files (knowing the shorts and the increase and decrease in the number of file turns) of Tab. (5), which was referred to as (y5), which represents the fifth of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model which is (43.366) Whereas, this value is acceptable because it falls within the periods specified for it [43.715-43.366] and as shown in Table (8).
6.We note that the internal nut of the ceramic insulators on the watt side, which was referred to as (S1), which is considered within the sixth goal of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model which is (750) as this value is acceptable and falls within the specified period for it [850-750] and as shown in Table (8).

7.We note that the external nut of the ceramic insulators on the watt side, which was referred to as (S2), which is considered within the sixth goal of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model which is (700) as this value is acceptable and falls within the specified period for it [800-700] and as shown in Table (8).

8.We note that fixing the cover, which was referred to as (S3), which is considered within the sixth goal of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model, which is (230) as this value is acceptable and falls within the specified period (310-230)] And as shown in Table (8).

9.We note that the pressure relief valve device, which was referred to as (S4), which is considered within the sixth objective of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model which is (68) as this value is acceptable and falls within the specified period for it [92 -68] And as shown in Table (8).

10. We note that the length (A), which was referred to as (S5), which is considered within the sixth goal of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model, which is (1444) as this value is acceptable and falls within the specified period for it [1446 -1444] and as shown in Table (8).

11. We note that the offer (B), which was referred to as (S6), which is considered within the sixth goal of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model, which is (959), as this value is acceptable and falls within the specified period for it [961 -959] and as shown in Table (8).

12. We note that the height (C), which was referred to as (S7), which is considered within the sixth goal of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model which is (1131) as this value is acceptable and falls within the specified period for it [1135 -1131] and as shown in Table (8).

13. We note that the lift weight, which was referred to as (S8), which is considered within the sixth goal of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model, which is (854) as this value is acceptable and falls within the specified period for it (855-854)] and as shown in Table (8).

14. We note that the total weight without oil, which was referred to as (S9), which is considered within the sixth goal of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model which is (1094) as this value is acceptable and falls within the specified period for it [1096 -1094] and as shown in Table (8).

15. We note that the total weight with oil, which was referred to as (S10), which is considered within the sixth goal of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model which is (1378) as this value is acceptable and falls within the specified period for it [1380 -1378] and as shown in Table (8).

Table (8): Comparison of the final results using lexicographic goal programming with the specified periods

Results obtained using Lingo program	measuring unit	The periods specified for it	Variables of the production process	s_i
750		850-750	The inner nut of the low-end ceramic insulator	s_1
700		800-700	The external nut of low-end ceramic insulators	s_2
230		310-230	Install the cover	s_3
68		92-68	Pressure relief valve device	s_4
1444	Mm	1446-1444	Length (A)	s_5
959	Mm	961-959	Width (B)	s_6
1131	Mm	1135-1131	Height (C)	s_7
854	Kg	855-854	Lifting weight	s_8
1094	Kg	1096-1094	Total weight without oil	s_9
1378	Kg	1380-1378	Total weight with oil	s_{10}
-	measuring unit	The periods specified for it	Outputs of the production process	y_i
47.933	V	48.317-47.933	Transfer ratio between files (knowing the shorts and the increase and decrease in the number of turns of the file) for the tab. (1)	y_1
46.792	V	47.167-46.792	The conversion ratio between files (knowing the shorts and the increase and decrease in the number of turns of the file) for the tab. (2)	y_2
45.650	V	46.016-45.650	The conversion ratio between files (knowing the shorts and the increase and decrease in the number of turns of the file) for the tab. (3)	y_3
44.509	V	44.866-44.509	The conversion ratio between files	y_4

			(knowing the shorts and the increase and decrease in the number of turns of the file) for the tab. (4)	
43.366	**V**	**43.715-43.366**	**The conversion ratio between files (knowing the shorts and the increase and decrease by the number of turns of the file) for the tab. (5)**	y_5

By finding the first goal of the multi-objectives mathematical model for the final assembly section, the other objectives were achieved. Therefore, it is not necessary to solve the mathematical models for the other goals and be satisfied with the results achieved from solving the mathematical model for the first goal.

8. Discussing the results of the quality control section:

Through table (9) we observe that all results fall within the specified periods for each variable, where:

1.We note that (No Load current), which has been referred to as (y_1) which represents the first goal of the desired goals, where its value appeared after the monitoring process on it and using lexicographic goal programming model which is (0.2), where this value is acceptable because it falls within the specified period. [2.6-0.2] and as shown in Table (9).

2.We note that (No load losses), which was referred to as (y_2)which represents the second goal of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model which is (680) as this value is acceptable because it falls within the specified period. [1058-680] and as shown in Table (9).

3.We notice that (Load losses), which was referred to as (y_3)which represents the third goal of the desired goals, as its value appeared after the observation process on it and using lexicographic goal programming model which is (4341.5), as this value is acceptable and falls within the specified period for it [4341.5- 4000] and as shown in Table (9).

4.We note that (Impedance voltage), which was referred to as (y_4)which represents the fourth of the desired goals, as its value appeared after the monitoring process on it and by using lexicographic goal programming model, which is (4) as this value is acceptable because it falls within the specified period[5-4] and as shown in Table (9).

5.We note that (Voltage Regulation), which was referred to as (y_5)which represents the fifth of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model, which is (1) as this value is acceptable because it falls within the specified period[1.257 -1] and as shown in Table (9).

6.We note that the conversion ratio between files (knowing the shorts and the increase and decrease in the number of turns of the file) for tab. (1), which is referred to as (s_1)which is considered among the sixth goal of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model, namely (47.933) as this value is acceptable because it falls within the period specified for it [48.317-47.933] and as shown in Table (9).
7.We note that the conversion ratio between files (knowing the shorts and the increase and decrease in the number of turns of the file) for tab. (2), which was referred to as (s_2)which is considered among the sixth goal of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model, namely (46.792) as this value is acceptable because it falls within the periods specified for it [47.167-46.792] and as shown in Table (9).
8.We note that the conversion ratio between files (knowing the shorts and the increase and decrease in the number of turns of the file) for tab. (3), which is referred to as (s_3), which is considered among the sixth goal of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model, namely (46.016) as this value is acceptable and falls within the specified period [46.016-45.650] and as shown in Table (9).
9.We note that the conversion ratio between files (knowing the shorts and the increase and decrease in the number of turns of the file) for Tab. (4), which was referred to as (s_4)which is considered among the sixth goal of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model, namely (44.509) as this value is acceptable because it falls within the periods specified for it [44.866-44.509] and as shown in Table (9).
10. We note that the conversion ratio between files (knowing the shorts and the increase and decrease in the number of file turns) of Tab. (5), which is referred to as (s_5)which is considered among the sixth goal of the desired goals, as its value appeared after the monitoring process on it and using lexicographic goal programming model, namely (43,366) as this value is acceptable because it falls within the periods specified for it [43,715-43,366] and as shown in Table (9).

Table (9): Comparison of the final results using lexicographic goal programming with the specified periods

Results obtained using Lingo program	Measuring unit	The periods specified for it	Variables of the production process	s_i
47.933	V	48.317-47.933	Transfer ratio between files (knowing the shorts and the increase and decrease in the number of turns of the file) for the tab. (1)	s_1
46.792	V	47.167-46.792	The conversion ratio between files (knowing the shorts and the increase and decrease in the number of turns of the file) for the tab. (2)	s_2

46.016	**V**	**46.016-45.650**	**The conversion ratio between files (knowing the shorts and the increase and decrease in the number of turns of the file) for the tab. (3)**	s_3
44.509	**V**	**44.866-44.509**	**The conversion ratio between files (knowing the shorts and the increase and decrease in the number of turns of the file) for the tab. (4)**	s_4
43.366	**V**	**43.715-43.366**	**The conversion ratio between files (knowing the shorts and the increase and decrease by the number of turns of the file) for the tab. (5)**	s_5
-	**measuring unit**	**The periods specified for it**	**Outputs of the production process**	y_i
0.2	**V**	**2.6-0.20**	**No Load Current**	y_1
680	**W**	**1058-680**	**No Load Losses**	y_2
4341.5	**W**	**4341.5-4000**	**Load Losses**	y_3
4	**V**	**5-4**	**Impedance voltage**	y_4
1	**V**	**1.257-1**	**Voltage Regulation**	y_5

By finding the first goal of the multi-objectives mathematical model for a for a quality control section, the other objectives were achieved. Therefore, it is not necessary to solve the mathematical models for the other goals and be satisfied with the results achieved from solving the mathematical model for the first goal.

9. Conclusions:

Through the field study that we conducted in the Diyala State Company for Electrical Industries, a quantitative problem was addressed, namely how to design a quality control system using the method of programming objectives, the following results were reached:

1) Although Diyala State Company for Electrical Industries is concerned with quality, some products are subject to malfunctions due to insufficient and adequate control over them and the adoption of personal experience and simple sports methods and not using modern and advanced sports methods to control the quality of their products.

2) The design of a product quality control system for the company and with the presence of several standards is a quantitative decision problem where the levels of inputs for the production process and its variables are determined in order to meet the specifications of the required product.

3) In this study a formulation of goal programming model was found, which allows modeling problems to design a system for controlling the quality of the company's products.
4) The mathematical formulation of the goals is specially designed to search for a satisfactory solution that achieves the least possible deviations from all the target values for all goals that have been determined by the decision maker for each section.
5) The solution by Lexicographic goal programming method has flexibility and finding the optimal or satisfactory solution for the decision-maker.
6) Through the mathematical model that was applied in the sections (outer and inner iron core, winding and insulation, final assembly and quality control), we find that the results were accurate, acceptable and within the permissible limits.

10.Recommendations:

Through what was mentioned in this research and based on the results that have been reached, we can provide some recommendations that we deem appropriate for what has been reached in this research, as follows:
1) Holding workshops for decision-makers, engineers and employees according to their specializations to introduce the Lingo program and how to introduce and apply mathematical models to control production quality for various industrial products and its flexibility in adjusting the inputs according to the changes in the factory.
2) Conducting training courses for decision-makers, engineers and employees to introduce quantitative and mathematical methods, especially programming goals and their broad capabilities in finding efficient solutions to many of the goals that the decision-maker aspires to achieve simultaneously, in preparation for trying to apply this method in Diyala State Company for Electrical Industries.
3) Implement effective quality systems in Diyala State Company for Electrical Industries.
4) Increasing awareness and disseminating quality concepts in the company.

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تصميم نظام لرقابة الجودة باستعمال اسلوب برمجة الاهداف – بحث تطبيقي

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Received:9/2/2021 Accepted:23/2/2021 Published: March/ 2021

مستخلص البحث:

نظرا للتطور المستمر في المجتمع وتعدد رغبات الزبائن ومواكبتهم لهذا التطور وبحثهم عن جودة ومتانة السلعة التي تقدم لهم الاداء الافضل والتي تلبي احتياجاتهم ورغباتهم، كل هذا ادى الى اعتبار الجودة من الميزات التنافسية التي تتنافس الكثير من الشركات الصناعية عليها والتي تهم الزبائن ويبحثون عنها. ان مشكلة البحث اظهرت ان شركة ديالى العامة للصناعات الكهربائية تعتمد على بعض الأساليب البسيطة والخبرة الشخصية لمراقبة جودة المنتجات ولا تعتمد الأساليب العلمية والبرامج الحديثة. ان الهدف من هذا البحث هو تصميم نظام لمراقبة جودة انتاج المحولة (400\11 KVA) من خلال استعمال اسلوب يساعد على اتخاذ القرارات ذات الطابع الكمي المتعدد الاهداف وهو اسلوب برمجة الاهداف الليكسوكرافية الذي استعمله الباحث لدمج افضليات متخذ القرار في مراقبة جودة انتاج المحولة المذكورة حيث تم استعمال البرنامجين (Excel, Lingo) في بناء وحل النموذج الرياضي الذي تم تطبيقه في الأقسام (القلب الحديدي الخارجي والداخلي، اللف والعزل، التجميع النهائي والسيطرة النوعية). اتسمت النتائج المستحصل عليها بالكفاءة حيث حققت اقل الانحرافات الممكنة عن جميع القيم المستهدفة لجميع الاهداف والتي تم تحديدها من قبل متخذ القرار لكل قسم.

المصطلحات الرئيسة للبحث: الجودة ، رقابة الجودة ، اسلوب برمجة الأهداف الليكسوكرافية.