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THE POSSIBILITY OF APPLYING GREEN QUALITY FUNCTION DEPLOYMENT (GQFD); CASE STUDY IN GENERAL COMPANY FOR AL-MISHRAQ SULFUR

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ABSTRACT:
The research focuses on showing the extent to which the requirements of GQFD can be applied to the alum product, as the research was adopted in its conceptual framework, GQFD and its requirements. The problem of the study is the possibility of designing a high quality, low cost and environmentally friendly product using GQFD houses. After the conceptual framework was crystallized, a hypothetical model was developed that reflects the nature of the work of GQFD, and a hypothesis was formulated to test the diagnosis of the possibility of applying the requirements of GQFD. The researchers reached the most important conclusions: The proposed improvements for the company in accordance with the implementation of the requirements of GQFD give priority to improving the requirements (maintenance and modernization of machines, eligibility and efficiency of working personnel, stability of specifications, raw materials and packaging, energy, manufacturing cost, marketing costs), and with proposals, the most important of which are: preparing a series of houses GQFD to achieve customer satisfaction and friendship with the environment and low costs, thus improving the company's competitive position, and providing the production departments and laboratories with modern machines and equipment necessary for production, in a way that matches the level of technology of competitors used in the industry, especially for the alum product .

Keywords:
Green Quality Function Deployment, House of Quality, Green House, Cost House, Alum production plant.

INTRODUCTION

The contemporary market landscape revolves around customer satisfaction, friendship with the environment, and low costs, and this occupies importance to companies that are facing a number of challenges such as rapid developments, environmental restrictions and intensification of competition. Quality, function, environment) with regard to the stages of product production, and in order to reach that, the research started from a problem that (the possibility of designing a product of high quality, low cost and environment-friendly using GQFD houses), and through the proposed improvements to the target values and priorities in each house, a better design is made. product concept.

RESEARCH METHODOLOGY

Research Problem

Some companies still do not realize the importance of using modern technologies that keep pace with continuous changes and face severe competition and fluctuations in customers' tastes, which caused the cost, quality and environment aspects to be taken into consideration when designing the product, as the business environment today requires continuous and continuous attention to the customer's voice and orientation towards improvement based on quality that The companies verify the customer. As for the researched company, it suffers from competition in its field of activity, despite its long standing in this field and its possession of manpower and machines with great capabilities in its field of competence, and it lacks a comprehensive vision of the importance of GQFD requirements and how to manage them in a way that ensures them achieving competitive superiority in general. After the initial survey and repeated reviews of the General Company for Mishraq Sulfur, the study problem crystallized in the possibility of designing a high quality, low cost and environmentally friendly product using GQFD houses.

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Importance of Research

1. Improving the quality of its products, the center in improving the quality of its products, and the center in improving costs.
2. An issue related to the issues, challenges and challenges faced by companies in general and the General Company for Sulfur Al-Mishraq in particular, represents its share in being paving the way for the administrative leadership in the General Company for Sulfur Al-Mishraq from applying the requirements of GQFD according to its available human and technical capabilities.
3. Availability of information available for sale at competitive prices that are available to compete, because we achieve them in the environmental needs and marine costs.

Research Objectives

The research objective is mainly focused on the possibility of applying the requirements of GQFD and clarifying the contents and limits of this application at the level of the General Company for Mishraq Sulfur, as well as achieving the following objectives:

1. Presenting theoretical and practical frameworks for the management of the General Company for Sulfur Al-Mishraq on the concept, objectives and requirements of GQFD.
2. Building GQFD houses to study the customer's requirements, technical requirements, environmental influences and what affects them from the elements of the environmental stock of the product, and to determine the factors affected by reducing the cost and the cost elements of the product that can be reduced, to determine the proposed improvements for the alum product and to outperform the competitors.

Hypothetical Research Scheme

The systematic treatment of the research problem requires the design of a hypothetical scheme, which is shown in Figure (1), which refers to the stages of the research.

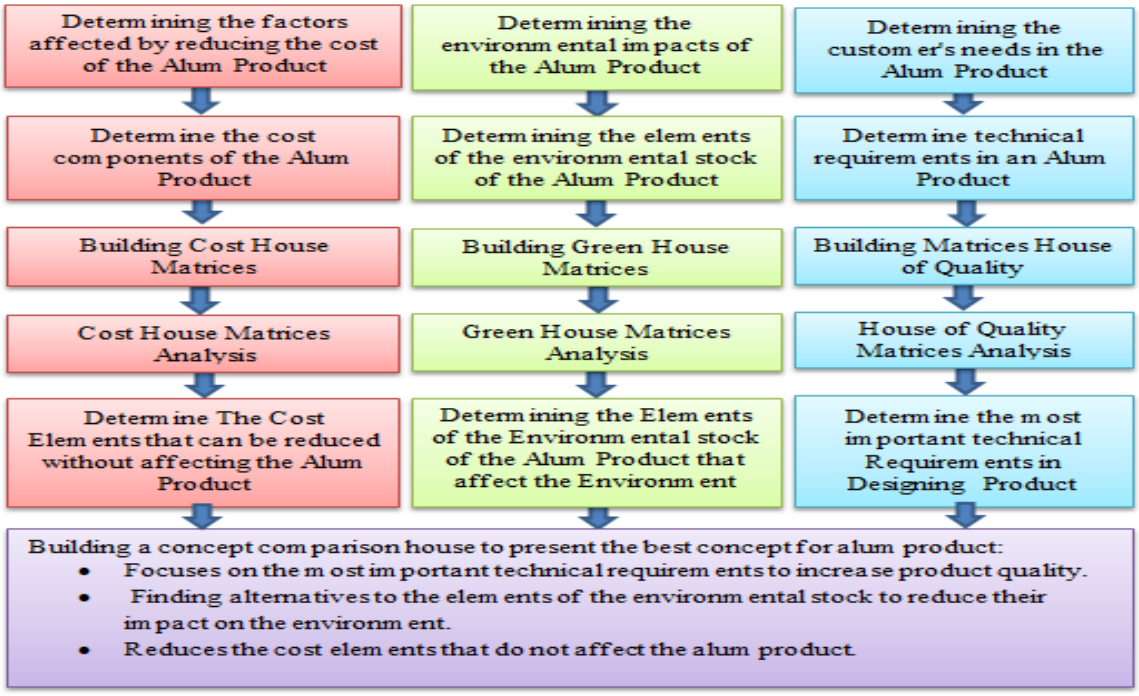

Fig. 1:Scheme Hypothesis Research

Research Hypothesis

In line with the current research objectives and in line with its hypothetical scheme, the following hypothesis will be relied upon: (The General Company for AL-Mishraq Sulfur has the possibility of applying the requirements of GQFD).

Tools And Methods Used In The Research

1. In completing the vocabulary of the theoretical framework of the research, the scientific sources represented by references and Arab and foreign literature related to the research requirements were based.

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2. Data collection tools: (personal interviews, personal observation, reports, records and data prepared by the company and lab, questionnaire form).
3. The data analysis tool is GQFD Houses.

Limits Of Research

The limits of the search were limited to the following:

1. Spatial limits: the alum production plant in the General Company for Mishraq Sulfur.
2. Human limits: According to the current research requirements, the categories (middle management, executive management, employees, and customers) were approved for the General Company for Mishraq Sulfur.
3. Temporal limits: The temporal limits of the research extended from 11/1/2021 to 9/15/2022.

Research Methodology

The study method is an art of organizing ideas and presenting them in a way that contributes to revealing the truth [1]. One, whether observation, inquiry and personal interview that leads to direct access to information. [2] believes that the case study is a comprehensive and accurate analysis of a phenomenon, as it attempts to obtain sufficient information about the case under study with a focus on a specific aspect of it, and data on the researched case is collected according to an organized scientific method.

Description Of The Research Place And The Target Product

1. Description of the production organization under study and the rationale for its selection: The General Company for Mishraq Sulfur / Nineveh Governorate, which is one of the departments affiliated to the Ministry of Industry, was chosen. The selection of the current study came in light of the following justifications:
   - The researcher made an exploratory field visit to many production and service organizations before choosing the field of study, and these visits resulted in an important fact represented in the reluctance of most of these organizations from including the requirements of the study in their operations and practices of their daily activities, unlike what is the case with regard to the field of study, which is characterized by the application of The majority of the study.
   - The organization needs to implement the requirements of GQFD to achieve the best concept of its product.
2. Target product: A product (Alum) has been selected, for which GQFD houses will be built.

THEORETICAL FRAMEWORK FOR RESEARCH

This topic includes a framing of the contributions of a number of researchers by addressing the concept of GQFD and its requirements, which help to achieve the objectives of the company's management related to meeting the needs of the customer, being at the fore in the competitive position, friendship with the environment and low costs.

Origin And Concept Of The Green Deployment Tool For The Quality Function

One of the main advantages of using QFD in environmental design is the ability to review environmental needs during new product development by translating these needs into design specifications [3]. Zhang et al began developing the QFD starting in 1998, so that it could incorporate the quality, environment and cost aspects into its matrices [4]. Table (1) shows the stages of development of the green deployment of the quality function GQFD.

Table1: GQFD development stages

S	Stage	The Scientist	Date	Stage Details
1	GQFD I	Cristofari, et, al.	1996	It is the first release of GQFD that incorporates environmental issues into the design of new products by combining QFD and LCA.
2	GQFD II	Zhang, et, al.	1999	It is The second version of GQFD that incorporates combined between LCC with LCA and QFD.
3	GQFD III	Mehta and Wang	2001	Use the Ecoindicator 99 method to estimate the environmental impact of a product.
4	GQFD IV	Dong, et, al.	2002	Includes multi-attribute fuzzy utility theory for life cycle cost estimation.

[5] refers to GQFD as the application of the House of Quality structure, and the evaluation of concepts for an alternative product from the point of view of quality in the House of Quality (HoQ), and from

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the point of view of the environment in the House of Ecology (HoE). From the point of view of the cost in the House of Cost (HoC), a quality, environment and cost index is obtained in each house for each alternative, which uses a multi-criteria method to analyze it, in order to determine the best concept that meets these three requirements. [6] describes GQFD as "a contemporary approach that simulates global technical developments by providing a high-quality product that does not leave any environmental damage during the production and use stages, as well as enjoying an affordable price". According to [7] GQFD is the process of translating the customer's voice in accordance with the environmental objectives that enjoy an appropriate cost so that it does not affect the company or its customers and thus works to achieve the needs of customers according to environmental considerations and the ability to review environmental needs during the development of new products By translating those needs into technical specifications through communication within the organization and between its various departments, which achieves the best communication between the different departments in the company, which achieves optimal satisfaction for the needs of customers to produce the optimal product.

The two researchers see that GQFD is a system that works to achieve the best concept of the product, and the inputs to this system consist of a package of requirements, which are quality requirements, cost requirements and environmental requirements, Through the targeted values of each house, which are of high priority, in order to focus efforts towards these values, or through the house of comparing concepts to reach the best product design that increases customer satisfaction and reduces costs, taking into account the increase of friendship with the environment, as for the feedback They are the expected requirements that the organization seeks at points of sale by communicating with customers, competitors and the surrounding environment in order to produce products that exceed customer expectations for the purpose of astonishing the customer and outperforming competitors.

Stages Of Implementing The Green Publication Of The Quality Function

The GQFD methodology consists of four stages[8]:

1. The stage of defining technical requirements: In this stage, a "House of Quality (HOQ) is established, which enables the design team to meet the needs of customers and translate them into technical standards to work on by the design team, as the House of Quality is established for all the concepts of the product under study, Several matrices are created at this stage, in order to bring a final matrix consisting of technical parameters to a level of detail that the design team may deem necessary.
2. The stage of creating cost and environmental data: In this stage, the "green house" (GH) and the "cost house" (CH) have been created. The green house documents the life cycle inventory loads of product options, and the impacts on the environment. Expressing these effects in terms of the values of the environmental indicators. As for the cost house, it documents the life cycle costs associated with the concept of the product. Both the green house and the cost house were established for all the concepts of the product under study. The outputs are used as inputs in the later stages.
3. Product Concept Comparison Phase: In this phase a "Concept Comparison Matrix" was created, in which all options for the products under consideration are documented with their quality, cost and environmental attributes. These data are derived from the House of Quality, the Green House and the Cost House respectively, at this stage the best product concept is selected.
4. Product Design (Process) Stage: In this stage QFD techniques are used to develop an optimized manufacturing process for the product concept selected in the third stage.

Green Publication Requirements For Quality Function

The green deployment of the quality function consists of three requirements: the quality requirement, which is represented by the quality function deployment technology (QFD), the environmental requirement (green), which is represented by life cycle analysis (LCA), and the cost requirement, which is represented by life cycle costs (LCC):

1. **Quality Function Deployment:** Understanding the customer's requirements and thinking according to the quality systems approach, as well as maximizing the positive quality that adds value through the adoption of comprehensive quality systems to satisfy the customer and the strategy to stay ahead of all this is the real content of the concept of QFD, and the basis of the entrance is a map called the Quality House, which is a map of concepts for communications and planning Multi-departmental and multi-functional, the designation of

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QFD expresses its true purpose of satisfying the customer (Quality) by translating their needs into designs and ensuring that all functions within the company (Function) work together to segment its activities and with high consistency into details and details of the details, enabling the Measured and controlled (Deployment Deployment), the meanings of publishing in Japanese go beyond its counterpart according to the English term, as it indicates the spread or dissemination of activities, in the sense of practicing the activities of analyzing customer needs to reveal hidden needs from them and then setting the priorities of those requirements, translating the needs and priorities into organizational responses so that focus All activities of workers are on critical tasks, so QFD means that all members of the organization are responsible for producing products of a desirable quality [9]. Based on a survey and analysis of the above, the two researchers see that QFD is a system, its main inputs are customer requirements and its operations are the matrices used to translate customer requirements into appropriate technical requirements at each stage of production and analysis. On the inputs to produce a product that works to (delight) the customer and outsmart the competitors.

2. **Life Cycle Assessment:**. [8] indicates that LCA is a complex work consisting of three phases: “inventory analysis”, “impact analysis” and “improvement analysis”. This approach considers all material and energy transfers involved in raw material extraction, processing and manufacturing, including from cradle to grave of a product. LCA can be used as a comprehensive and rigorous approach to evaluate different alternatives to prevent contamination [10]. The essence of the LCA is to assess the environmental, economic and technological impacts of a material, process or product over its lifespan from production to waste or preferably, to re-creation in the same or other beneficial form, It is clear that industry has a significant impact on the potential for global warming, and human health [11]. According to [12] (LCA) is a tool used to assess the environmental impacts of a product, process or activity, the concept of (LCA) is based on the assumption that the industrial system is closely related to the environment in which the industry is located and the industrial system is formed From the inputs and outputs, the system inputs are in the form of material taken from the environment and its outputs will be discharged back to the environment. The two researcher believes that (LCA) is a tool for evaluating the potential environmental accumulations and effects associated with the stages of industrial and production processes from the inputs through the processes to the outputs, interpreting these accumulations and their effects, classifying them and working to reduce them by finding alternatives to the elements of the environmental stock that cause them in order to reduce damage to the quality of the ecosystem and reduce exhaustion resources, reduce harm to human health, and reduce waste of all kinds.
3. **Life cycle cost:** Indicates [13] It is important to realize that the LCC is a point estimate, which reflects the average of units, occasions, and customers, Therefore, it is difficult to obtain accurate figures from the LCC, since the basic components of the LCC are (1) the life of the product and (2) the cost of the product, The costs are divided into two parts: initial costs and operating expenses, Initial costs refer to all costs associated with purchasing the product, Operating expenses mainly reflect the expenses of energy use, maintenance and service, Life cycle cost is defined as the sum of all money paid to an average product during its useful life, taking into account In the future money consideration, the LCC number reflects the discounted present values of these expenditures. Life Cycle Cost (LCC) is used to assess the costs incurred by products during their life cycle as the efforts of the cost reduction program, as well as related to efforts made to create environmentally friendly products [14]. The two researcher believes that (LCC) is a tool for evaluating the direct and indirect costs associated with the stages of industrial and production processes from the inputs through the processes to the outputs, interpreting these costs, classifying them and calling them (cost elements) and Reducing the elements whose reduction does not negatively affect the factors that are affected by cost reduction (quality, function, environment) for the product, in order to reduce the total costs of the product and ensure its sale at competitive prices.

Green Publishing Houses For The Quality Function

The three houses (quality house, green house, cost house) that make up the green publication of the quality function will be discussed, which refers to a set of improvements that will collectively be the

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house of philosophy (concept comparison house) which represents the full vision of the requirements of the green publication of the quality function:

1. **House of Quality:** Is one of the processes that It includes the deployment of the quality function as it is linked to product planning, while other operations will be related to the design of each of the product, operations and production [9]. The two researchers see (HOQ) as the means that works to translate the customer's requirements "what he wants" into "how." The engineer voted to meet those requirements and learn what competitors offer and how well they meet those requirements for customers and work to amaze the customer and outperform competitors by designing a product that exceeds expectations The customer, the quality house consists of six main matrices: the customer requirements matrix, the engineering characteristics matrix, the competitive evaluation matrix, the relations matrix between customer requirements and engineering properties, the trade-offs matrix, the target values matrix as shown in Figure (2).

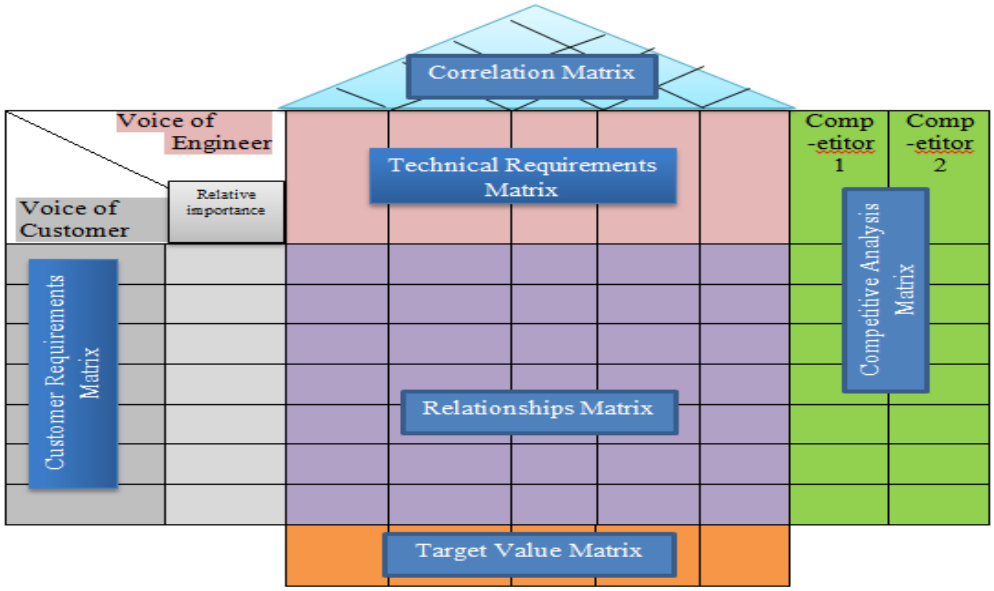

Fig. 2: shows the structure of the House of Quality

2. **Green House:** To assess the environmental performance of each product concept, the Life Cycle Assessment (LCA) methodology is applied and reported in Green House (GH), and by looking at [15] and [16] [10] [17] and at the disposal of the two researcher, based on the existing data for the field and the case of the study, it was concluded that the design of the green house needs six basic steps according to a set of matrices called (green house matrices), which are as Comes: : Figure (3).
   - Environmental Inventory Matrix (Technical features of the environment): The elements of the environmental inventory are taken from the product life cycle, and the amount of each element is determined in the measurement field at the bottom of the environmental inventory matrix.
   - Environmental Impact Matrix: It includes (the impact on human health, the impact on the quality of the ecosystem, the impact on resources), which contribute to these effects are the elements of the environmental stock.
   - Relationship Matrix: This matrix shows the contribution of each element of the environmental stockpile to each type of environmental impact and the extent of the strength of this impact, symbolized by "+".
   - Correlation Matrix: This matrix shows the strength of the relationship between the technical features of the environment (the elements of the ecological inventory) and the purpose is to identify the features that support each other.
   - Impact Sum Matrix: It is the sum of the effect of each element of the environmental inventory on all units of the environmental impact.

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- Priorities Matrix: It is a list of impact priorities for each element of the environmental inventory in relation to the size of the impact caused by this element on all units of environmental impact.

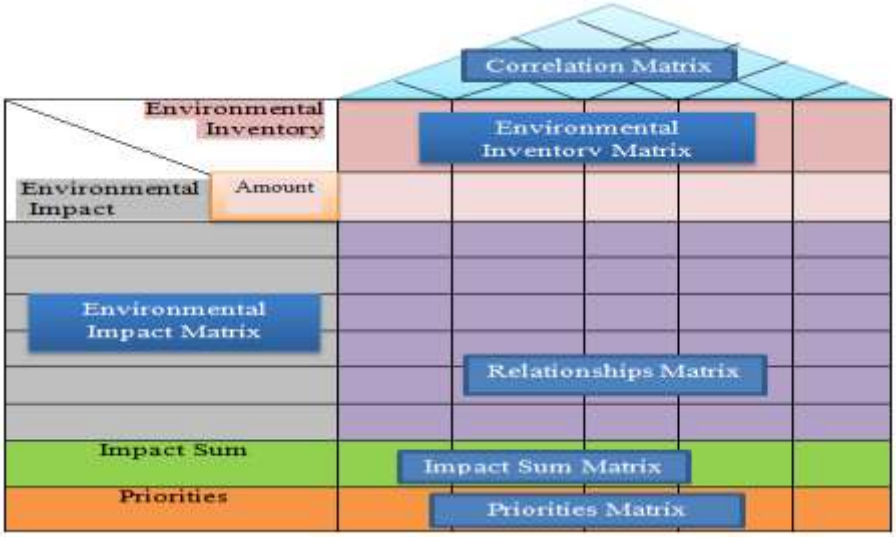

Fig. 3: The structure of the Green House

The two researchers believe that the Green House (GH) is the means that works to clarify the elements of the environmental stock taken from the life cycle of the product and to show the extent of the impact of each element of the ecological stock on each type of environmental impact (the impact on human health, the impact on the quality of the ecosystem, the impact on resources), and thus determine the elements of the environmental stock that are most priority in relation to the size of their impact on the units of environmental impact, which the company should direct efforts towards reducing this impact by finding appropriate alternatives in order to produce a product more friendly with the environment at all stages of its life cycle.

3. **Cost House:** And by looking at [15] and [16] [10] [17], and at the disposal of the two researcher based on the existing data for the field and case of the study, it was reached That the cost house design needs six basic steps according to a set of matrices called (the cost house matrices), which are as follows: Fig. 4
   - Cost Items Matrix: cost elements are taken from the product life cycle, and the cost of each element is determined in the measurement field below the matrix of cost elements.
   - Matrix of Affected Factors of Cost Reduction: it includes (reducibility, quality, function, environment) as the “reducibility” represents the extent to which each cost element can be reduced through the following symbols (+, 0), where the symbol “+” represents the ability to reduce costs. The cost element can be reduced, while the symbol "0" represents the non-ability of the cost element to be reduced. As for the "quality" factor, it represents the type of effect of reducing the cost component on the quality of the product (negative or positive) and how strong this effect is. As for the "function" factor, it represents the type of effect of reducing the cost component on the function of the product (negative or positive) and how strong this effect is. As for the “environment” factor, it represents the type of impact of cost reduction on the environment (negative or positive) and the extent of this effect.
   - Relationship Matrix: This matrix shows the relationship between the cost elements and the factors that are affected by cost reduction, by knowing whether the cost element can be reduced or not, and if it is subject to reduction, what is the type of effect of the reduction on the factors that are affected by cost reduction, whether it is negative or positive. And the strength of this effect.
   - Correlation Matrix: This matrix shows the relationship between the cost elements, whether they are positive or negative, or the absence of a relationship.

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- Impact sum Matrix: It is the sum of the effect of each component of the cost on all the factors that are affected by the cost reduction.
- Priorities Matrix: Through this matrix, the target values are determined, which represent the priorities of the greatest value for the cost elements, which have a greater cost with a greater possibility of reduction and less negative effects in relation to the factors affected by cost reduction.

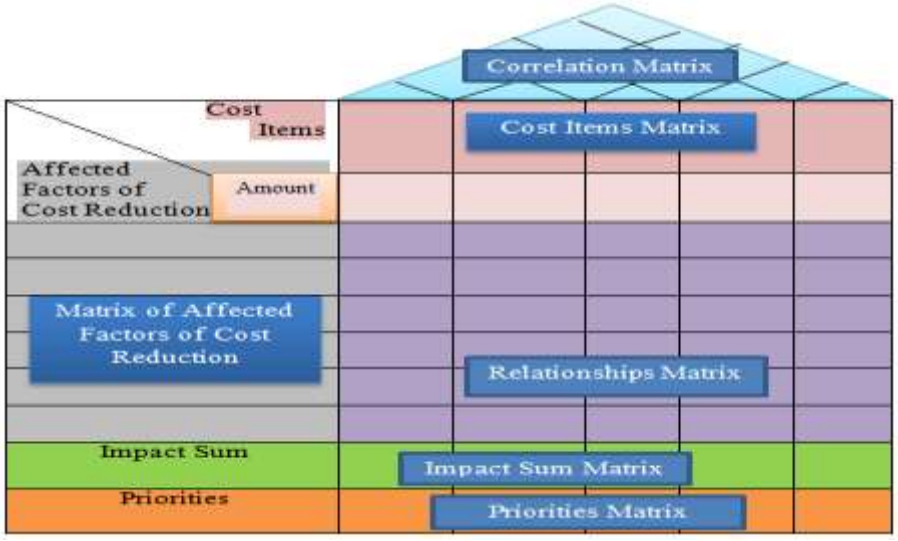

Fig. 4: Cost House Structure

The two researcher see that the cost house (CH) is the means that works to clarify the elements of costs taken from the life cycle of the product and to show the extent to which these elements are susceptible to reduction, as well as to show the extent of the impact of the elements of costs that have been reduced on the factors affected by cost reduction, and thus determine the target values, which are the most cost elements A priority with regard to cost reduction, which the company should direct efforts towards reducing in order to produce a product at a low cost that enables the company to outperform competitors in the market.

4. **Concept Comparison House:** And by looking at [16], [14], and at the disposal of the two researcher based on the existing data for the field and the case of the study and what is imposed by the Iraqi specification No. (5093 for the year 2019) issued by The Central Organization for Standardization and Quality Control prevented restrictions on the inputs of the production process of the alum product through the inability to suggest alternative concepts for the alum product on which the concept comparison house was based to choose the best concept for the product. Its way is to obtain the best concept of the product, which is: Fig. 5:
   - Product Structure Matrix: This matrix includes all the technical requirements in the quality house, all the elements of the environmental inventory of the green house, and all the cost elements of the cost house.
   - Correlation Matrix: This matrix shows the relationship between the elements and requirements of the product structure matrix.
   - Target Elements and Requirements Matrix: This matrix includes the target requirements in the quality house, the most priority environmental inventory elements in the green house, and the most priority cost elements in the cost house.
   - Product Best Concept Matrix: This matrix includes the proposed improvements to the elements and requirements of the target values matrix in addition to the rest of the product structure matrix elements, thus obtaining the best product concept.

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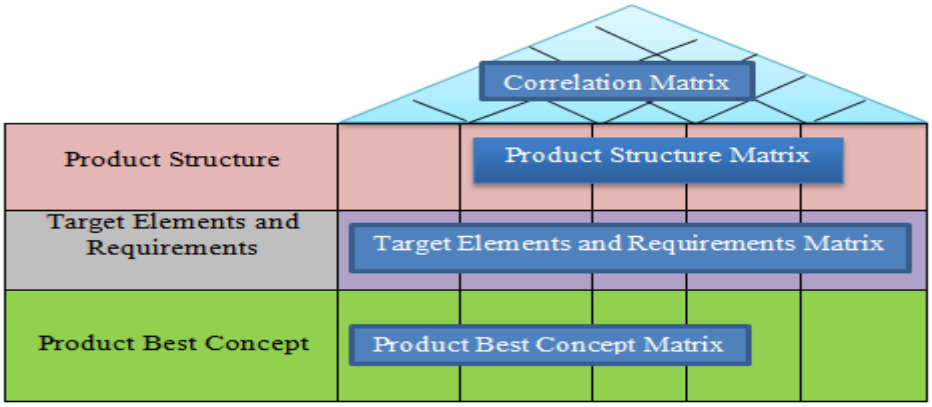

Fig. 5: Concept Comparison House Structure For Alum Product

Based on the above, the two researchers see that the concept comparison house is a way to choose the best concept of the product by making improvements to the elements and requirements of the target value matrix and the most priority for each GQFD house in addition to the rest of the elements of the product structure matrix, and thus obtaining the best concept of the product that satisfies the customer and a friend The environment at all stages of its life cycle at a low cost.

APPLIED SIDE OF THE RESEARCH / BUILDING GQFD HOUSES FOR ALUM PRODUCER

Building A House of Quality for The Alum Product

The theoretical side indicates that the construction of the house of quality is carried out according to six basic matrices, which are:

1. Customer Requirements Matrix (Voice of Customer) It is defined by:
   - Determining the clients of the General Company for Al-Mishraq Sulfur for the alum product by conducting personal interviews with (the director of the production department, the director of the research and development department, the director of the quality department, the director of the commercial department) and they are (the Ministry of Oil, the general directorates of water and sewage all, industry and mineral companies, the Water Department Baghdad).
   - Determining the customer's needs and the relative importance of each need. The purchase contracts between the company, the site of the study, and the company's customers were reviewed, as well as a field visit to each of the North Oil Company, the North Gas Company, the Nineveh Water Department, and the Kirkuk Water Department, which deals directly with the company under study. The needs agreed upon by customers in the alum product, and the degree of importance of each need compared to the rest of the needs were reached using the preference matrix that is being guided as shown in Table 2.

Table 2: Quantitative measure of importance [18]

Details	Degree
Equally important	1
Little importance to one another	3
Strong	5
Very strong	7
Very very powerful	9
average values	8, 6, 4, 2

The needs of customers and the degree of importance of each need are clarified as in Table (3).

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Table 3: Matrix of customer needs, and the relative importance of each need

customer requirements	Relative importance
Product quality (product performance and efficacy)	**5**
Specifications (conforming to Iraqi specification 5093 of 2019)	**5**
Price (fair price and price discount system)	**3**
Date (clear production date and expiry date)	**2**
Packing (Quality of packing (packed with bags or carry a fill))	**1**
Transportation (delivery services and obtaining security approvals to facilitate transportation)	**3**
Customer service (attention and welcome to the customer, scheduled appointments and quality of service provided)	**4**

2. Technical Requirements Matrix (Voice of Engineer): It is determined by conducting interviews with specialized engineers and technicians from experts working in the alum production plant at the company's research site, as well as officials in the following departments: (commercial, research and development, quality, production, planning), They were informed of the customer's needs, and they were asked to identify the technical requirements that meet each of the customer's needs. The result of these meetings was the engineer's voice matrix shown in Figure (6), and the following is an explanation of each requirement:
   - Maintenance and Modernization of Machines: This process is considered the essential part of the sustainability of the production process and ensuring that it keeps pace with developments, through continuous examination of machines and detection of the causes of malfunctions and work to avoid them.
   - Eligibility and Efficiency of Working Individuals: they are the workers who are characterized by efficiency and effectiveness, which make the production process go without stopping, thus reducing waste in all its aspects.
   - Methods of Packaging: It is the science, art and technology of packing the product with bags for the purpose of attracting the customer, protecting the product and ensuring its safety from all external influences.
   - Stability of Specifications: It is the work to conform the product to the Iraqi specification and the stability of its quality.
   - Preparation Method: It is the method by which the product is prepared for the customer.
3. Competitive Analysis Matrix (Market Voice**):** The steps to be taken for the purpose of building the competitive analysis matrix are:
   - Determining the competing companies of Al-Mishraq Sulfur Company (alum producer) in the local market, namely: (Turkish Akkim Kimya Company, Lebanon Chemicals Company).
   - Identifying the level of ability of each competing company to meet each of the customer's needs, through personal interviews with workers in the company's departments (commercial affairs department, quality department, production department), and personal interviews with workers in (purchasing department, research department) And development) in the customer companies, the matrix of competitors was built as in Fig. 6. Where the letters mentioned in the figure refer to the following: **The letter A**: indicates the availability of this requirement to a strong degree by the competitor. **The letter B**: indicates the availability of this requirement to a moderate degree by the competitor. **The letter C**: indicates that the competitor has a weak degree of this requirement**.**
4. Relationships Matrix**:** In order to design and build a relations matrix that includes determining the relationship between the customer's needs and the technical requirements that meet those needs, interviews were conducted with specialists from engineers and technicians from experts working in the alum production plant in the company, the site of the search, as well as

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officials in the following sections: (Research and development, quality, production, planning), as they were informed of the customer's needs, and they were asked to determine the relationship of all technical requirements to each of the customer's needs, each individually, as shown in Fig. 6.

This matrix shows the type and degree of relationship between each of the customer's needs and with each of the technical requirements of the product.

Where the following numbers refer to:

- **(5)** A very strong relationship between the customer requirement and the technical requirement.
- **(4)** A strong relationship between the customer requirement and the technical requirement.
- **(3)** A moderate relationship between the customer requirement and the technical requirement.
- **(2)** It indicates a weak relationship between the customer requirement and the technical requirement.
- **(1)** Indicates that there is no relationship between the customer's requirement and the technical requirement.

5. Correlation Matrix: The Correlation matrix was determined through observations and personal interviews with those in charge of the alum production, and the exchange matrix illustrates the relationship between technical requirements, as shown in Figure (6), where the (+) sign indicates that the relationship between the two design requirements (the technical requirement) is a positive relationship, while the sign (-) indicates that the relationship between the two design requirements (the technical requirement) is a negative relationship, and the square that does not contain a sign indicates that there is no relationship between the design requirements.
6. Target Value Matrix**:** It is the matrix that shows the level of importance of the technical requirements, as the target value is extracted by building a quality house in the usual way based on the data obtained through the product of the values of the relationship matrix with the relative importance that corresponds to each customer requirement and thus collecting The products of the multiplication for each column and the result are the target values of the technical requirements, as in Figure (6).

Voice of Customer / Voice of Engineer	Relative importance	Maintenance and Modernization of Machines	Eligibility and Efficiency of Working Individuals	Methods of packaging	Stability of Specifications	Preparation Method	Turkish Akkim Kimya Company	Lebanon Chemicals Company
Product quality	5	5	5	1	4	1	A	B
Specifications	5	5	4	1	5	1	B	B
Price	3	4	4	2	4	1	B	A
Date	2	2	1	2	2	1	A	B
Packing	1	3	2	5	1	5	A	C
Transportation	3	1	2	1	1	1	B	C
Customer service	4	3	3	1	1	5	C	C
		84	79	32	69	43		

Fig. 6: Target value using the house of quality initial design

Where the results showed that the technical requirements "**maintenance and modernization of machines**", "**qualification and efficiency of working personnel**" and "**stability of specifications**" are

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the most important requirements that the company should direct efforts towards improving these requirements in order to produce a high quality product that enables the company to outperform competitors In the market.

Building The Green House For The Alum Product

Theoretical approach to the other side of the research indicates that the construction of the green house is according to six matrices, which are:

1. The elements included in the environmental inventory: the elements of the environment that are related to the environmental influences are taken from the life cycle of the alum product, and the amount of an element is determined in the measurement field located at the bottom of the environmental matrix Alum product life. page (4)

Table. 4: Matrix of environmental inventory elements

Environmental Inventory	Raw Materials and Packaging	Energy
Amount	267000	2000

2. Environmental Impact Matrix (Damage Category): It includes (the impact on human health, the impact on the quality of the ecosystem, the impact on resources) [16], which contribute to these effects are the elements of the environmental stock. Figure (7). Recalling:
   - Damage to the quality of the ecosystem: waste and polluting gases resulting from the production process, negative environmental effects, pollution of the environment during the production process, environmental accidents, global warming.
   - Damage to human health: Weak promotion of health, safety and environment by joint steps with customers, damages to agricultural crops, damages that affect the living environment, environmental risks that affect customers from their exposure.
   - Damage to resources: accumulation of waste resulting from production, water pollution, soil pollution, waste of resources.
3. Relationship Matrix: In order to design and build a relationship matrix that includes determining the contribution of each element of the environmental stockpile to each type of environmental impact and the extent of the strength of this impact, interviews were conducted with specialists from engineers and technicians from experts working in the alum production plant In the company, the research site, as well as the officials in the following departments: (engineering inspection, quality, production, auditing and control). Some kind of environmental impact individually. The alum product during its life cycle has little environmental impact, particularly in the raw material processing, transportation and finishing stages. Therefore, it is necessary to carry out the analysis to be able to determine the environmental impact criteria. Figure (7) shows the relationship matrix which is the most important part of the ecological house.
   The symbol (+ +) indicates the existence of a relationship with a strong positive impact between each of the environmental stock element of alum and the element of environmental impact, and the symbol (+) indicates the existence of a relationship with a weak positive impact, and the empty square indicates the absence of a relationship, and the symbol (-) indicates the existence of a weak negative impact relationship between the environmental stock component of alum and the environmental impact component, while the symbol (- -) indicates a strong negative impact relationship.
4. Correlation Matrix: It is a matrix that shows the relationship between the elements of the environmental stock of the structure of the alum product, and clarifies the nature of this relationship, is it positive, negative or not, as the symbol (+) indicates a positive relationship, and the symbol (-) indicates The presence of a negative relationship, and the empty box indicates the absence of a relationship, we note that there is no relationship between the elements of the environmental stock during the life cycle of the alum product as shown in Figure (7).
5. Impact Sum Matrix: the sum of the environmental impacts of each component of the alum's ecological inventory.
6. Priorities Matrix: It is displayed on the total effect of each element, taking into account the value of the scale. As shown in Figure (7).
   Thus, the results that appeared in Figure (7) Green House show that the elements (raw materials, packaging) and (energy) are the alternatives that have the most impact on the

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environment during the production stages of alum (target values), which the company should direct efforts towards improving in order to be Producing an environmentally friendly product enables the company to outperform competitors in the market.

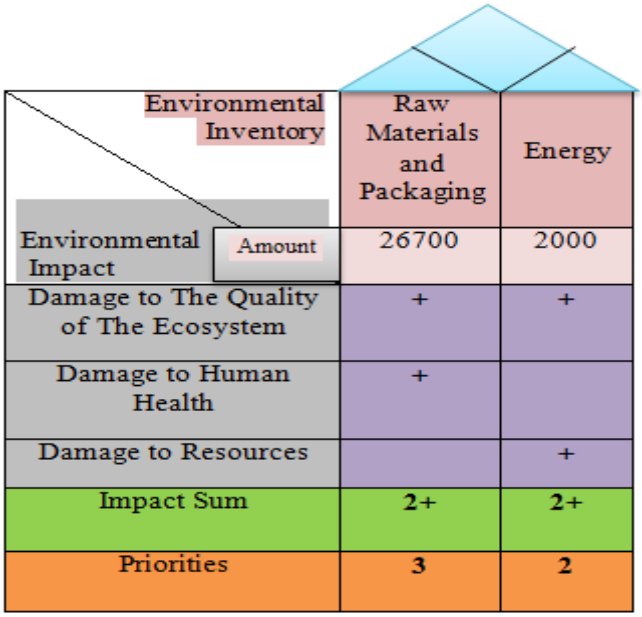

Fig. 7: Green House

Building A Cost House For The Alum Product

The theoretical side of the research indicates that the construction of the cost house is carried out according to six matrices, namely:

1. Matrix of Cost Items: cost elements are taken from the life cycle of the alum product, and the cost of each element is determined in the measurement field below the matrix of cost elements according to the costs associated with these elements during the stages of the life cycle of the alum product in relation to the production of one ton. Table(5)

Table. 5: Matrix of cost elements for alum product

Cost Items	Manufacturing Costs	Marketing Costs	Administrative Costs	Total Costs
Amount	395000	8000	12000	415000

where it indicates:

- Manufacturing Cost: includes salaries, waste, raw materials, packaging, spare tools, maintenance and other costs.
- Marketing Costs: include promotion and advertising costs and other marketing costs.
- Administrative Costs: include stationery and all office supplies that are used in the administration and other administrative costs.
- Total Costs: These are all costs of alum production per ton.

2. Matrix of Affected Factors of Cost Reduction: It includes (reducibility, quality, job, environment) and as we indicated in the theoretical aspect of this research (the second topic) about the details of this matrix, as shown in Figure (8).
3. Relationship Matrix: In order to design and build the relationship matrix in the cost house, which includes determining the contribution of reducing each element of the cost to each type of factors that are affected by cost reduction and the extent of the strength of this effect, interviews were conducted with specialists from engineers and technicians. The workers in the alum production plant in the company, the site of the research, as well as the officials in the following departments: (engineering inspection, quality control, quality, production, audit and control), as they were briefed on each of the matrix of cost elements and the matrix of factors affected by cost reduction, and they were asked to specify Which of the cost elements

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can be reduced, and what is the contribution of the effect of reducing each element of the cost matrix to each of the factors that are affected by the cost reduction, each individually, and what kind of effect is this, as shown in Figure (8).

4. Correlation Matrix: It is a matrix that shows the relationship between the cost elements of the structure of the alum product, and clarifies the nature of this relationship, whether it is positive or negative or not, as shown in Figure (8).
5. Impact Sum Matrix: It is one of the cost house matrices whose function is to show the sum of the effects of reducing each element of the cost on the factors that are affected by the cost reduction, as shown in Figure (8).
6. Priorities Matrix: It is one of the cost house matrices whose function is to show the priorities of reduction for each element of the cost, through the highest total effect of each cost element on the factors affected by cost reduction, taking into account the value of the scale (with the largest cost). As shown in Figure (8).

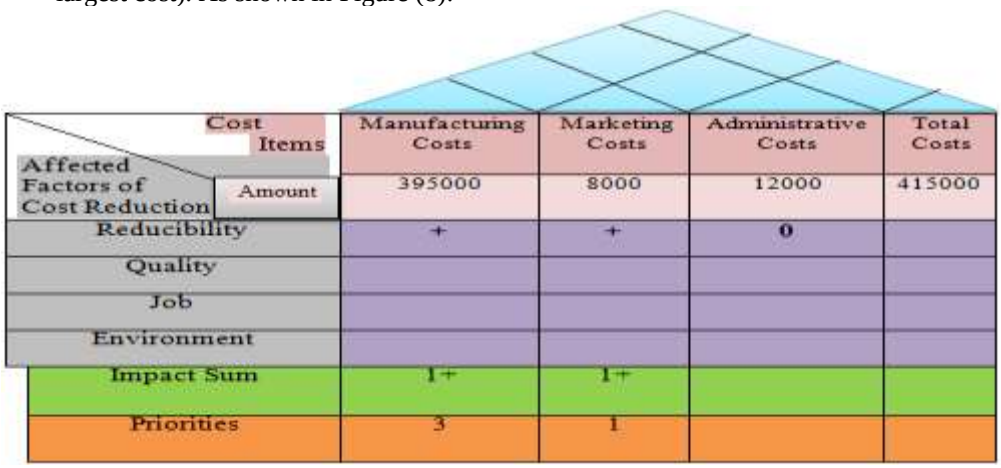

Fig. 8: Cost House

Figure (8) shows the cost house of the alum product, and through the size of the cost and the ability to reduce, the results showed that the two most priority cost components "manufacturing cost" and "marketing costs" are the target values that the company should direct efforts towards reducing in order to produce the alum product at a cost Low level enables the company to outperform competitors in the market.

Building A Concept Comparison House

The theoretical side of the research indicates that the construction of the concept comparison house is carried out according to four matrices, which were clarified in the theoretical side, which are:

1. Product Structure Matrix:
2. Correlation Matrix:
3. Target Elements and Requirements Matrix:
4. Product Concept Matrix:

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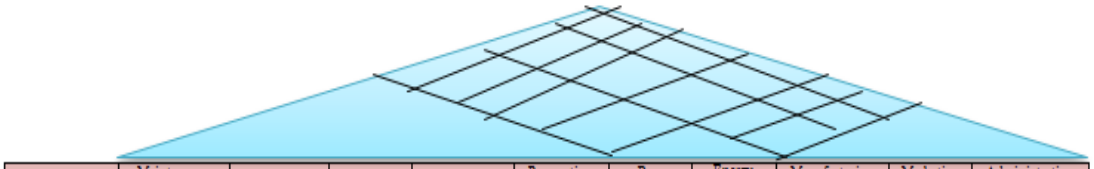

Product Structure	Maintenance and Modernization of Machines	Eligibility and Efficiency of Working Individuals	Methods of packaging	Stability of Specifications	Preparation Method	Raw Materials and Packaging	Energy	Manufacturing Costs	Marketing Costs	Administrative Costs
Target Elements and Requirements	Maintenance and Modernization of Machines	Eligibility and Efficiency of Working Individuals		Stability of Specifications		Raw Materials and Packaging	Energy	Manufacturing Costs	Marketing Costs	Administrative Costs
Product Best Concept	Upgrading machines and adopting preventive maintenance	Establish training and development programs for employees	Approved packaging methods	Use of all checks at all stages of production	approved processing method	Use the electric belt to load the product	Use of solar panels to generate electricity	Focus on preventive maintenance to reduce the cost of spare tools	Reduce advertising to reduce marketing costs	approved administrative costs

Fig. 8: Concept Comparison House

Figure (9) shows the details of the work of the concept comparison house, through which a concept of a high quality, environmentally friendly and low cost alum product is designed in all stages of its life cycle by making improvements and alternatives on the most priority elements and target values of the House of Quality , Green House and Cost House And come up with a concept of alum product that satisfies the customer and overcomes the competitors.

CONCLUSIONS AND SUGGESTIONS

Conclusions

1. Alum is one of the best-selling products of the General Company for Al-Mishraq Sulfur in the Iraqi market.
2. The General Company for Al-Mishraq Sulfur / Alum Production Plant has the appropriate ground for the possibility of applying the requirements of GQFD.
3. The results of the study revealed that the administrative leaders and employees of the General Company for Sulfur Al-Mishraq had acceptable knowledge about the concept of GQFD requirements.
4. The proposed improvements of the company in accordance with the implementation of the requirements of GQFD give priority to improving the factors (maintenance and modernization of machines, qualification and efficiency of working personnel, stability of specifications, raw materials and packaging, energy, manufacturing cost, marketing costs) so that it can achieve the best concept of the product.
5. It turns out that there is a basic role for the series of houses (the quality house, the green house, the cost house) and because of its importance in GQFD on the parts of the product and identifying the basic parts that need to be prepared, prepared and mastered in quality to reach the best concept of the product for the purpose of translating the customer's needs into technical characteristics The product in the Quality House and the translation of the extent to which the environmental inventory elements of the alum product can be reduced on the environment in the green house and the translation of the extent to which the cost elements of the alum product can be reduced without affecting the quality, function and environment in the cost house. Determining the customer's needs, determining the technical requirements of the product, determining the elements of the environmental stock, determining the environmental impacts, determining the cost elements, determining the factors that are affected by cost reduction).

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6. The advanced application of GQFD affects the improvement of (customer value, environmental friendliness, cost reduction) than it was before this application of the product under study.

Suggestions

1. Preparing and preparing the GQFD series of houses for its importance in linking and integrating the total production process, which begins with the customer and ends with the customer as the tool that achieves customer satisfaction and ensures friendship with the environment and low costs.
2. Adopting the application of the GQFD tool in all Iraqi organizations, as it is the modern and important tool in product design and development to achieve the best concept of the product (customer satisfaction, environment friendly and low cost).
3. Directing the company's interest in applying the GQFD series of houses in order to improve its competitive position, through the use of studies, research centers and specialized consultations in this field, and seeking to create and develop the administrative and technical staff in the relevant functional departments regarding the applications and work of this tool.
4. Preparing a comprehensive plan to identify and provide the needs of the production departments and laboratories of modern machines and equipment necessary for production in order to raise the level of production in quantity and quality, in a manner that matches the level of technology of competitors used in the industry, especially for the alum product.

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