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USING CONCURRENT ENGINEERING TECHNIQUE TO DEVELOP THE PRODUCT AND REDUCE ITS COSTS

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ABSTRACT

The aim of the research is to introduce the concurrent engineering technology and its characteristics, concept and mechanisms, and to identify the most prominent benefits achieved in applying concurrent engineering technology, and to identify the role of concurrent engineering technology in reducing costs and developing products, and in order to determine the location of the General Electric Industries Company product sample, the research sample in relation to similar products to the rest of the company , The researcher used the Quality Function Deployment Tool (QFD), as it is one of the best tools for converting customer needs and quality requirements into product characteristics, developing product quality design, and reducing costs, as well as the Quality Function Deployment (QFD) is considered an evolutionary tool Strong, with a wide range of applications. It also incorporates the desires and requirements of customers in product design, which is what concurrent engineering tools (DFM, DFX, DFA) seek to achieve.

Introduction

Concurrent engineering considered as one of the technologies resulted from environmental changes and developments, especially the extreme competition between economic units that generated pressure on these units to achieve clear goals such as reducing unnecessary and undue costs, improving the quality of processes and products, also reducing design time and manufacturing and assembly time, furthermore to provide enough flexibility in responding to the constant changes of the client's needs, desires, requirements, tastes and behaviors, and thus to help in achieving competitive advantage and excellence over others.

First topic: Research Methodology

First: Research Problem

The ability of companies to introduce new products, and their ability to develop these products, reduce their costs and increase their quality constantly, are a major reason for their success and existence in the market. The research problem revolves around the following question:

(What are the differences between developing the new product according to the traditional model and developing the product according to the concurrent engineering technique in the aspects of reducing costs?)

"Does the use of concurrent engineering technique effect on cost reduction and product development?"

Second: Research objectives

The research aims at several goals, which are according to the following:

1. Clarify the philosophy of concurrent engineering technique, its characteristics, concept and mechanisms.
2. Determine the most prominent benefits achieved in applying concurrent engineering technique.
3. Clarify the role of concurrent engineering technique in reducing costs and developing products.

Third: Research importance

The process of developing the product and reducing its costs considered as the major milestone of the company's success and its ability to establish a position in the market and its existence in it, and the unsuccessful development of the product leads to the failure of the product and consequently will lead to the company's direct and indirect loss. It also leads to wasted effort and time. The practical importance of the research is to demonstrate the importance of identifying and meeting customer requirements for that. Therefore, the current research came to highlight the role of concurrent engineering in developing the product and reducing costs.

Fourth: Research hypotheses

The research aims at test the following hypotheses:

1. Concurrent engineering significantly affects on cost reduction.
2. Concurrent engineering significantly affects on the time of product development.
3. Concurrent engineering significantly affects on the redevelopment of the new product.

Second topic: theoretical aspect, a conceptual approach to the concurrent engineering

First: Concept of Concurrent Engineering

Researchers did not agree on developing a specific concept of concurrent engineering, there are who look at it from an administrative or accounting point of view and there are who look at it from an engineering and technical point of view, therefore these researchers provided three approaches to define its concept, as concurrent engineering is seen as an administrative philosophy, technique, or multifunctional team.

(Makinen) defined concurrent engineering as the philosophy for cost reduction that can be applied at every stage of the product life cycle and the matter is more effective and efficient at the design stage, as it can be applied in the manufacturing and support stage, whereas following this technique can achieve savings equivalent to 40% of the total cost of the product as a result of savings achieved in time. Accordingly, (Makinen) indicated the possibility of using concurrent engineering at every stage of the product life cycle including the design stage and its subsequent stages. ”(20: 2011, Makinen)

(Mani) considers concurrent engineering as a multi-functional work team that aims at finding specific solutions to the various problems that can occur when designing, manufacturing and assembling the product through the

simultaneous development of the product and the process, and this development represents one of the fundamental solutions through which access to Global markets by distinguishing between cost and time. Therefore, Mani and others emphasized that concurrent engineering is a way to find fundamental solutions to problems that may arise when undertaking product design, manufacture and assembly operations with the help of a multifunctional team, by performing these operations simultaneously to achieve cost and time savings. (Mani,et.al.,2015: 129)

Concurrent engineering can be considered as a technique that depend on a set of tools and methods through which design and development operations can be carried out simultaneously by taking advantage of all available information along the value chain, in addition to the possibility of applying them in manufacturing, assembly and marketing operations, by forming a multi-team Jobs sets an appropriate business plan aimed at achieving savings in both cost and time, while maintaining an acceptable level of quality, in addition to providing adequate flexibility in responding to any changes in the needs, desires and requirements of customers, and thus these can help Technique to achieve competitive advantage.

Second: Importance of Concurrent Engineering Technique

The importance of concurrent engineering technique comes from its appropriateness to the changes in the business environment and its ability to respond to changes in the needs, desires and requirements of customers quickly in a better and faster way than competitors offer in the market, and the importance of concurrent engineering technique can be illustrated through a set of points, as follows: (Akaberi, 2011:42).

1. Concurrent engineering technique is an important method to improve product development processes by finding appropriate solutions to the problems that accompany the design, manufacturing and assembling by agreeing on the opinions of all relevant individuals and departments to improve the value of both the economic unit and the customer
2. The importance of concurrent engineering technique is shown by the major role it can play in taking decisions with the help of a multi-functional team, which focuses on customers for achieving many savings in design time and manufacturing and assembling time to achieve a competitive advantage
3. This technique helps in providing guidelines for maintenance during the design phase (which was not present when following the sequential design, which increases the quality of the design by meeting the product design specifications and making it free of defects and problems. (Batalha 2012: 124)).
4. Concurrent engineering technique focuses on teamwork to ensure effective coordination, communication and cooperation between all parties in the economic unit, in addition to using a set of devices, equipment, programs and tools for designing, manufacturing, assembling and marketing the product.
5. Concurrent engineering technique is an important tool to reduce product development time through savings achieved in time during the

design phase and the manufacturing and assembling stage, which helps the economic unit to achieve many cost savings related to the time saved.

6. This technique helps the idea quickly reach the market as a result of reducing the design and development time of the product by resolving design decisions and introducing them early, in addition to the synchronization of manufacturing and assembling processes homogeneous in the economic unit.

Accordingly, the importance of concurrent engineering technique raise from its suitability for the business environment and the accompanying rapid and successive changes and developments, as it helps in developing new and existing products, and also helps in making decisions regarding design, manufacturing and assembling operations, as well as its dependence on teamwork and its focus on effective coordination among all parties through the multi-functional work team, and most importantly, it is an important method for achieving cost and time savings while maintaining the required quality level.

Third: Objectives & Principles of Concurrent Engineering Technique:

The concurrent engineering technique as an important tool for simultaneously designing, manufacturing and assembling processes seeks to achieve a set of goals, and these goals can be clarified through the following points:

1) Achieving time savings: - Time management is one of the main pillars of the work of concurrent engineering technique, and thus it aims to achieve the following savings: 2011, Crawford (96).

A. Design time savings: Simultaneous design activities are based on the principle of symmetry or parallelism in order to achieve complementarity between these activities and their performance simultaneously, which results in reduced process time for product design, process, and supply chain.

B. Savings at the time of manufacture and assembly: - The arrangement of the factory in the form of working cells and the carrying out of synchronous design operations can create a suitable ground for simultaneous manufacturing and assembly operations also, which helps in achieving savings at the time of these operations.

2) Achieving cost savings: Carrying out operations simultaneously helps to achieve savings in the total cost of the product by eliminating the cost of time that does not add value, in addition to creativity and excellence in the use of available resources, the best use, and this technique helps in controlling the cost Reducing unnecessary and unjustified ones and making them at their lowest level.

3) Maintaining the required level of quality: Concurrent engineering technique seeks to adhere to the required quality levels and standards, by exploiting knowledge and talents in orderly ways to achieve quality with its two dimensions of conformity to specifications and suitability of customer use, in addition to achieving a degree of compatibility between each of the costs Quality, time and optimum combination.

(4Rapid response to changes in the needs and desires of customers: - In light of the competitive business environment, the needs and desires of customers are in a state of change and renewed constantly, and until the

economic unit can distinguish the element of flexibility in responding to these changes, then God can use concurrent engineering technique to develop its current products or Designing and manufacturing new products with faster time, lower cost, and higher quality compared to what competitors offer, Toyota has succeeded in achieving this. (Yassine 2003: 125)

5) Achieving Competitive Advantage: - It is noticed from the previous four points that concurrent engineering technique helps achieve competitive advantage through its four dimensions, namely: Less Cost , higher quality, less customer response time, and flexibility to respond to changes in customer needs. (Tayal) has confirmed that this technique can achieve many benefits in the long run related to improving the indicators of cost, quality, time, and flexibility which means achieving a competitive advantage.

6) Improving performance: Concurrent engineering technique helps create a good working environment from the first time, through which it will reduce redundancy in reviewing and refining prototypes of designs, and helps in accurate understanding of development processes and early detection of design problems and improving the quality of processes and products and reducing their costs, and thus Achieving noticeable performance improvements. Based on the above, it is noted that the concurrent engineering technique aims to achieve a competitive advantage through its four dimensions, which include cost, quality, time and flexibility, in addition to helping it to improve both the operational and strategic performance of the economic unit.

Fourth: concurrent engineering technique tools.

(Tools of Concurrent Engineering Technique)

The concurrent engineering technique tools are set of methods that aim to activate the design, manufacture and assembly processes by using and integrating a group of technologies and expert systems in addition to the integration of communication networks and information exchange in the economic unit, as the success of this technique depends on the extent of the successful application of its tools as well as its development And its breadth to include all operations and perform them simultaneously, and thus concurrent engineering seeks to achieve integration between the elements of analysis to develop product specifications, so each of the design and manufacturing requirements as well as components, functions and pain will be studied Respond to the other required in an integrated and interconnected manner, taking into account the move away from designing unnecessary components and functions that the customer does not want, in addition to searching for better components that perform the same functions with the highest quality and lowest cost in order to achieve the highest benefit for customers through which they can obtain their confidence, as well as work on disposal From unnecessary costs to achieving the best competition in the market to help deliver products to customers that can meet their needs and requirements. (Van Beek, 2011: 69)

Fifth: Requirements for the implementation of concurrent engineering technique (Implementation: Requirements of Concurrent Engineering Technique)

This paragraph includes the following:

1- A Multidisciplinary Concurrent Engineering Team:

(Mani) and others view the multifunctional team as a group of individuals working in the economic unit including administrators, accountants, engineers, technicians, maintenance workers, salesmen and others, who work together to achieve Goal or common goals (Mani, et. al, 2015: 130)

2 - Concurrent Engineering Action Plan

After forming a multi-functional concurrent engineering work team, the team begins to exploit the knowledge and talents of its members collaboratively to solve problems more broadly, and a concurrent engineering work plan that must be flexible enough to respond to new needs and requirements is prepared according to what customers want they prefer it. Among the tasks carried out by the concurrent multi-functional engineering work team regarding this technique plan of action are the following:.

(Simms, 2012: 231)

A. Determine the components and specifications of the product that the customer desires in accordance with his expectations.

B. Determine appropriate methods for designing, manufacturing and assembling the product, while specifying maintenance requirements.

C. Analyzing product functions and linking each job to the required manufacturing methods and processes.

D. Achieving design for manufacturing and assembly operations depends on synchronization in the performance of these operations.

Sixth: Introduction to applying concurrent engineering technique

(Approaches for Implementation of Concurrent Engineering Technique) There are two approaches to applying concurrent engineering technique, as follows: (Sharafi,2012: 89)

1- Two Dimensions Concurrent Engineering Approach:

This entrance is based on designing both the product and the process simultaneously, designing the different parts of the product in conjunction with the process design that includes production planning, manufacturing methods and facilities and the resources required in this process, can lead Shortening the product life cycle, which helps in getting the product early to the market.

2 - Three Dimensions Concurrent Engineering Approach

Some researchers see that the simultaneous design of the product and the process are insufficient for the work of concurrent engineering technique to work effectively under the business environment, so a third dimension has been added which is the design of the supply chain, and therefore in the context of three-dimensional concurrent engineering each of Product, process and supply chain simultaneously in order to greatly benefit from the savings in the total time of the product life cycle. There are three technical dimensions of synchronous engineering, and can be illustrated by the following:- (Portioli, 2003: 145)

The first dimension: - Product design: The product design requires the design of its components, functions, specifications, and characteristics, taking into account their conformity with the needs, desires, and requirements of the customer in a way that makes the product suitable for its use in terms of good job performance and high quality, and thus requires the

participation of design engineers competent individuals In Operations Management and Production Management, beside

Manufacturing, assembly and maintenance engineers to do the job, with salesmen participating in the design process because they are in direct contact with customers so that they can carefully determine the needs of those customers.

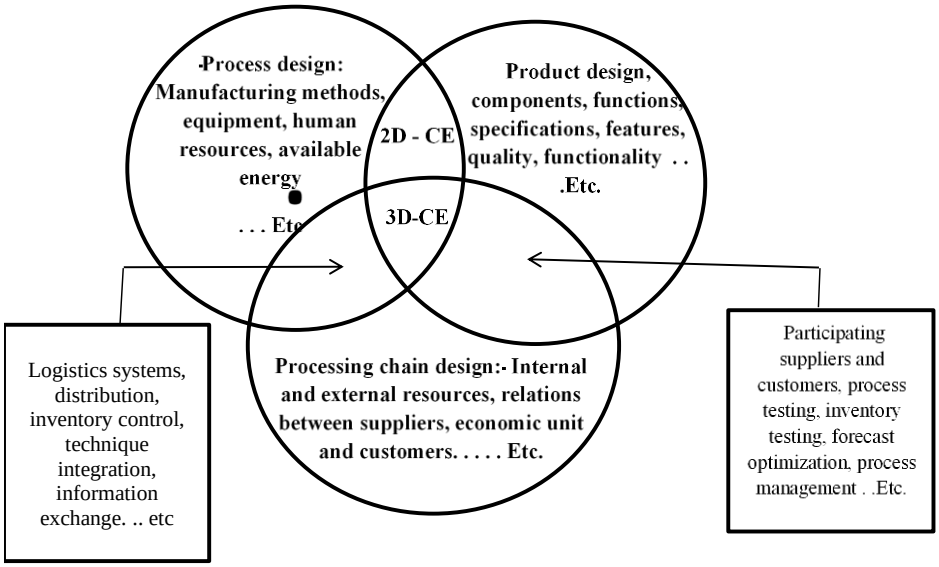
The second dimension: - Process Design: The process design requires defining all activities required to implement production systems in the economic unit, including manufacturing methods, technique, equipment and human resources involved in the manufacturing process, and thus it is the process by which a framework or shape is established for the resources and activities that make up the product with all its parts and components in order to satisfy The functional requirements required to convert raw materials into finished products, and in light of concurrent engineering technique, efforts are sought to define activities that can be carried out simultaneously with the determination of the required human and material resources, whether they are specific to operations. Design or manufacturing processes and assembly. (Jacobs, 2009:147)

Third dimension: - Supplying Chain Design:. The supply chain is an integral part of the strategic planning process in the economic unit because it includes all its activities, operations and functions, as it indicates the ability of the economic unit to coordinate and cooperate between each of the suppliers, manufacturers and distribution channels in addition to customers in order to produce low-cost and high-quality products that can It meets their needs and requirements, and the supply chain is seen as managing the flow of information, materials, products, and additional services of value to both suppliers, economic units, and customers, and (Horngren) and others are seen as the capacity of the unit Dealing with suppliers to provide materials consistent with their capabilities and resources in order to produce products that can meet the needs and requirements of customers, and during the design of the supply chain, the strategic network that connects suppliers, economic unit, and customers is defined, including buying and selling.

Concurrent 2D and 3D architecture can be illustrated by the following:

Figure 3

Two-dimensional (2D-CE) and Three-dimensional (3D-CE) simultaneous engineering



Source: (Albizzati, Fabio 2012, "Establishing 3D - CE Approach in Product Development Practices", PHD Thesis in Management, Economics and Industrial Engineering, University of Politico Milano, Italia, p: 24).

It is noticed through the above figure, that there is an overlap between the three dimensions of concurrent engineering technique. The product design requires the design of the process in addition to the design of the supply chain. When studying this technique, these dimensions need to be taken into consideration as much as possible, taking into account the customers 'needs of the products when carrying out the first phases of design. Concurrent 3D engineering (3D-CE) is more appropriate than two-dimensional (2D-CE) concurrent engineering because it is broader than it by an important dimension which is the design of the supply chain along with the design of both the product and the process, and thus this can satisfy these Cannula requirements of the business environment.

Accordingly, concurrent three-dimensional engineering(3D-CE)is more suitable to the requirements of the competitive business environment, as it helps to shorten the product life cycle, which leads to a real reduction in costs, time savings and quality maintenance, in addition to providing sufficient flexibility in responding to changes in the needs and desires of customers, as the synchronous design activities are based on the principle of symmetry or parallelism in order to achieve integration between these activities and perform them in a way

Simultaneous, which reduces process time for product design , process and supply chain. (65: 2011, Haizer)

Seventh: The phases of applying concurrent engineering technique

(Phases for Implementation of Concurrent Engineering Technique)

The researchers didn't differ too much in the basic phases of applying concurrent engineering technique, (Ogawa) indicated that there are three phases in the application of concurrent engineering technique, which are: the

Setup and Preparing phase and the design phase and the post-design phase, either (Moges) sees that there are four phases to apply this technique, which is similar to the phases put by (Ogawa) but he added a phase Review and evaluate designs as a third phase after the design phase, and these four phases can be illustrated by the following: (78: 2011, Crawford)

The first phase: Setup and Preparing phase :

The second phase: The design phase:

During this phase, the concurrent engineering technique is applied according to the plan stated with the establishment of the base of the third phase: the Review and Evaluation Phase: the fourth phase: Transition to Production Phase

The concurrent engineering technique goes through four phases that can be performed simultaneously, which are: the Setup and Preparing phase, the design phase, the review and evaluation phase, and finally the transition to production phase, and it can be said that the commitment of the design team to these phases and the implementation of design processes simultaneously can provide an appropriate ground to carry out manufacturing and assembly operations simultaneously also, which helps in achieving additional savings in cost and time, as well as improving the quality of both the product and the process and thus helping to meet the needs, desires and requirements of customers, which ultimately leads to helping the economic unit applied to this technique is to achieve competitive advantage and remain in

the business environment as well as growth and expansion.

The phases of applying concurrent engineering technique can be illustrated by the following form:

Figure (1): Phases of applying concurrent engineering technique

Second: the design phase 1) Application of concurrent engineering technique according to plan. 2) Establish a common database and exchange information quickly among members of the multifunctional team 3) The simultaneous design of the product, process and supply chain.	First: Setup and Preparing phase 1) Understand the principles of concurrent engineering technique. 2) Determine the reasons for the improvement process. 3) Determine the objectives of applying concurrent engineering technique. 4) Considering the harmony of the objectives of the simultaneous engineering technique with the economic unity strategy. 5) Appointment of the head of the concurrent engineering work team 6) Determine the required concurrent engineering technique tools. 7) Determine the capabilities and resources of the economic unit necessary to implement the concurrent engineering technique. 8) Adapting simultaneous engineering technique to the conditions of the economic unit. 9) Identify the important points of integration between activities. 10) Identify the individuals involved in applying concurrent engineering technique
Third: the Review and Evaluation Phase 1) Review the designs prepared for the product, process and supply chain, and change them as needed. 2) Evaluating designs by comparing the actual cost and target cost of previous designs with the estimated cost of current designs. 3) Acknowledging the final design and recommending its application.	
Fourth: Transition to Production Phase 1) Adherence to the design approved in the previous stage.	

2) Commitment to continuous improvement processes 3) Conducting manufacturing and assembly operations simultaneously	11) Ensuring that the application of this technique does not adversely affect both cost, quality, time, or flexibility . 12) Checking the standard performance indicators and making sure they are consistent with the economic unit strategy. 13) Develop a concurrent engineering business plan. 14) Work to determine the actual cost and the target cost of the product to be studied.

Source: (Moges, Alema 2007, "Concurrent Engineering and Implementations: A Case Study in Addis Engineering Center, Master Thesis in Mechanical Engineering, University of Addis Ababa, Ethiopia, p: 119).

The third topic: the practical side analyzing the results

First: a brief of the General Company for Electrical Industries

The General Company for Electrical Industries started its production through three production lines, but it was able to expand significantly to add production lines for new products in order to meet the needs of the Iraqi market. The company also worked and is constantly working to develop and improve the quality of its products by encouraging its employees to continuously search for access to high quality products.

The company produces different types of products for home use and products for industrial use. The most important of these products are: Split type (Naseem Al-Rafidain), wall and vertical air conditioner, window air conditioner (Naseem Al-Rafidain), water coolers (Salsabil), single and three-phase electric generators. With different couriers, box transformers, single-phase motors which are used in evaporative air coolers, water pump for evaporative air coolers, home water pump. . . . , And others. The company has a number of laboratories, each of which performs specific work. These laboratories are in:

Network and separate air conditioner lab, compressor lab, central air conditioner lab, motor lab, ministerial lab, transformer production lab, open lab, pump lab, lighting devices lab, bulb lab in Taji, the company markets its various products directly to its customers through:

Direct selling in the company, direct selling to state departments and private sector traders, and dealing with foreign investors through their exploitation of the company's human and material capabilities in exchange for sharing profits. The company has agents who specialize in marketing its products in the various governorates of Iraq. The company also provides maintenance for its products by providing after-sales services.

Second: The method of developing the new product in the company:

The company has a specialized research and development department that has the bulk of the responsibility for developing the company's products, as the department continuously evaluates the company's products using the reports provided by the after-sales services department, the marketing department, the information received from external customers, and even from the company's employees, To determine in this light which products need to be developed, the department will form the development team.The development team continues to work until the specific product development process is completed and the product model is manufactured and tested. After the success of the tests, the developed form is sent to one of the company's laboratories related to the product, so that this factory can produce the product, after which a new phase begins, the product that was developed is subject to design change in the event of any defects in it during the manufacturing process.

The researcher has chosen one of the company's products (three-taps water cooler) and because of:

1. It has been a long time since the company started producing this type of product.
2. The presence of similar devices of the same use by Iraqi and foreign companies in the market, which pushes towards the design of a product that is distinct from those products.

The water dispenser consists of four main complexes:

1. The body of the object (front, back, upper and lower parts, right side, left side, nerve center, medial base, pelvis and lattice).
2. Fan System (Fan Stand, Fan and Heat Exchanger (Condenser))
3. Cooling system (Compressor) , copper tubes, thermostat, fixing screws, faucets, drive filter, water raft, insulation and freight gas).
4. Cooling basin and its accessories.

More than one laboratory within the company participates in the production of three water taps, and the preparation time for assembling one water cooler is very long, reaching to 16158 seconds, equivalent to 269. 3 minutes equals 4 hours and 48 minutes, due to that

1) The long period of operation on the CNC machine to perform several successive perforations until reaching the required breakfast.
2) The dyeing process takes a long time of up to two hours per 200 pieces (front ,side, back,.. etc.)

Third: New development - evaluation of the previous development process

Despite the company's development of its product and the change in the product achieved with this development, and despite the reduction in the price of the fridge from 750,000 dinars before development to 400,000 dinars after development, as a result of reducing the costs of producing the fridge, in addition to the fundamental changes in the essential properties of the properties The fridge and its external appearance, but the new product did not achieve what was intended of it, as the demand for the product remains low, and on the other side the product still contains many defects, and the time period from the start of the company to the development process until the end of the process and then obtaining approvals on Starting a new production is a long time Was enough because new products appear more

sophisticated than the product developer at lower prices than its price, clearly, the product development process did not achieve what was required. In order to provide a different development process from the process that the company undertook in a manner that leads to distinguishing the product and making it more acceptable to customers, and based on what was stated in the theoretical side of this research,

The proposed development process for the water cooler product is three faucets through the use of concurrent engineering tools DFX, DFA, DFM, and throughout the development process with the aim of achieving a new level of performance by reducing or eliminating losses, damage, reducing costs, and speed of market access. . As the adoption of design for manufacture, design for assembly, and design for discrimination by the development teams contribute to addressing the high direct manufacturing costs, and helps to adopt the design from different departments first Powell.

In order to achieve the above, the company must take a set of clear procedures, which can help in achieving the goal, and these procedures include:

1- Forming one or more development teams, consisting of engineers or employees in different departments (administration, research and development, manufacturing, assembly, finance and marketing).

2 - Collecting information, as the information obtained must include everything related to the characteristics and work style of similar products and the materials involved in their manufacture.

3 - That the team work to seek the opinions of the primary users of the water cooler, and they, as previously passed by universities, institutes, schools, places of worship, state departments, public facilities. . . . . Etc.).

4- Knowing the basics of the problems that accompanied the previous development process, which is the length of the development period, the high cost of the refrigerator, the appearance of defects and the presence of losses in the production chain because of the poor design.

Fourth: Defining the problem - analyzing the company's process to develop the product:

In order to determine the problems that appeared in and after the process of developing a water cooler product in the General Company for Electrical Industries, it must be determined the reasons for not being able to buy the new product.

1 - Reasons for consumers' reluctance to buy the product:

The most important issue for the customer when considering the purchase of a refrigerator is the price of that refrigerator, regardless of the quality level of that refrigerator . This result may be prevalent at present, but it is not the best result for the customer or the company. The company, as an established company, is not ready to sacrifice its reputation and its trademark in order to market any quantity of the product without ascertaining the level of quality of that product. Because the failure of one of its products due to poor awareness means that consumers are reluctant to buy the rest of the company's products, and this generates a loss that the company does not accept. Therefore, the company insists that its products enjoy high quality.

By comparing the product of the General Company for Electrical Industries with three faucets from a refrigerator, and through repeated visits

to local markets, the researcher found that there are multiple types of refrigerators with the same Specifications of the fridge produced in the company, and the prices range between 280, 000 dinars and 330, 000 dinars for products produced from local private sector companies, and at prices higher than that for imported refrigerators.

2- Comparing the company's product with that of other companies through QFD:

In order to locate the product of the General Company for Electrical Industries relative to the products similar to the rest of the company, the researcher used the Quality Function Deployment Tool (QFD), as it is.

A - One of the best tools for converting customer needs and quality requirements into product characteristics, improving product design quality, and reducing costs.

B - QFD is a powerful development tool, with a wide range of applications.

It also incorporates customer desires and requirements into product design, which is what concurrent engineering tools (DFM, DFX, DFA) strive to achieve.

The Quality Deployment Function tool consists of six matrices which are the customer's voice, the engineer's voice, the relationship matrix, the competitors 'matrix, the relationship matrix, product design characteristics (quality house roof) and the evaluation matrix.

1- VOC Customer Voice:

The researcher has used several methods to collect the customer's voice, including exchanging ideas with the engineers of the research and development department responsible for designing a water cooler product, three taps and with the workers responsible for collecting the fridge in the company, reviewing complaints and warranty records, interacting with trade shows that sell the fridge produced in the company The General Company for Electrical Industries or similar products produced in other companies, and the visit of some of the customers who use the product and this step is essential in determining the influencing needs that establish the potential opportunities, after obtaining the customer's voice through the aforementioned sources, and visiting some of the User builder for the product, the data has been converted into customer requirements.

In light of this, the relative importance of customer needs was determined on a scale of 1 - 5 (where 5 indicates the most important need and 1 indicates the need is less important), and this arrangement was made on the basis of customer feedback obtained. Table (2) shows the relative importance of customer needs.

Table (2) the Relative Importance of Customers' Needs

sequence	Customer voice	Importance
1	Container for drinking water cups	1
2	Speed in water cooling	5
3	Water tank of adequate size	3
4	Cost-effective	5
5	Easy to clean	2
6	Attractive exterior design and convenient size	2

7	Low power consumption	4
8	The presence of a water purifier	5
9	Use of healthy materials appropriate for the user	4
10	Easy access to water	1
Table prepared by the researcher		

2- Matrix of technical specifications:

The information obtained from the customer's voice about customer requirements (WHATS), was discussed with design and manufacturing engineers and those responsible for collecting the fridge to determine the engineering properties and technical specifications that meet the customer's requirements (HOWs), the relative importance and comparison so that they are all used in building a quality house (HOQ) Water cooler has three faucets, table (3) shows the list of technical specifications (HOW's) for the water cooler that have been reached and that meet the customer's requirements.

Table (3) List for HOW's Water Cooler

sequence	HOW'S	Element NO.	Unit
1	The size of the compressor	2,4,7	HP
2	The body dimensions	1,3,4,5,6	Cm
3	Water basin dimensions	2,3,4,5,7,8,10	Cm
4	The size of the condenser	2,4,7	Rpm
5	Type of faucets	9,10	Subjective
6	Type of Basin metal	2,3,4,9	Subjective
7	The size of the mugs container	1,4,9	Cm
8	Sink cooling system	2,3,4,7,9	
9	Water purifier	4,7,8	RO
10	Body metal	4,5,6,9	Subjective

Table prepared by the researcher

3 - Relationship Matrix between (WHATS) (HOW`s):

Connecting customer requirements with technical specifications, we get the relationship between (WHATS) and (HOW's). Using symbols to represent the degree of relationship between customers' requirements (WHATS) and technical specifications (HOW's), then the numerical values are given, which will be used later to determine the cases of preference and absolute weights. Table 4 shows the symbols used and the corresponding numerical values.

4- New design:

After determining the main reasons for the lack of demand for the water cooler, three taps of the product in the General Company for Electrical Industries, and determining the requirements of customers and the characteristics that affect meeting those requirements. Before starting the product development process and in a way that leads to getting rid of all the negatives that appeared at the last product development of the company, a

road map must be defined by which the water cooler product can be developed in a way that leads to faster access to the market, meeting customer requirements, reducing costs and minimizing faults. To achieve this, critical success factors must be taken into consideration and the design process completed based on the principles of the concurrent engineering methodology. Drawing on concurrent engineering tools: Design for Manufacturing (DFM) and Design for DFA Assembly. By emphasizing looking at all possible designs to gradually narrow down the final design. Likewise, stress on removing activities that do not add value, ensuring the flow of activities, maximizing process speed, analyzing delay times, bottlenecks and waiting times, removing excess transport and reducing its costs.

5 - Is development and cost reduction consistent with the company's strategy: One of the company's strategies it seeks to achieve is to distinguish its products from similar products to competitors, and this is what the new design of the water cooler product sought three taps, the new design differs from the fridge design that the company previously developed In several aspects, Table (6) shows the parts covered and their status before and after development.

Table (4) the parts covered and their status before and after the development

No.	The name of the part or complex	The status before development	The status after the new development
1	The structure of the fridge	purchase from another company of colored iron	its production inside the company of colored iron with the possibility of producing the front face of the plastic
2	tank + 3 taps	purchased from another company from stainless steel	produced inside the company from stainless steel with the packaging of the upper cover with plastic
3	1/4 ton compressor	under development	replace the compressor type with a lower cost
4	fan + fan motor	larger fan	smaller fan
5	copper	large quantities of tubes of different diameters are used to manufacture condensers and cooling system	use small amounts of tubes in the cooling system
6	aluminum	Large quantities are used to manufacture The condensers	no need for it
7	net	Used the condenser as a heat exchanger	the use of the net at a lower cost
8	cooling gas	more gas	less gas
9	Mugs holder	does not exist	it was added

Among the aspects that the company's product can enjoy:

- The fridge is drawn from the plastic, because the technical capabilities available to the company make it possible to do this, noting that it provides in addition to the aesthetic side, it saves costs because the plastic is characterized by its low cost.

- Changing the cooling system from its previous position (copper pipes inside the tank) to the new position, the cooling pipes outside the tank.

- Another point of distinction is the holder of the feet. The company's refrigerator will be the only product produced in Iraq that has a cups holder.

-In addition to the possibility of adding water filter inside the fridge (the presence of a vacuum inside the body) and according to the desire of the customer, it is possible to obtain water with a high degree of purity.

- The cost of the refrigerator, the cost of the refrigerator, after development, was 193550 Dinar at a price lower than the price of any refrigerator of the same class on the market.

6 - The possibility of implementing the new design in the company:

The company owns

Technical capabilities: The company has several plants that are currently suspended due to the lack of raw materials, or because there is no demand for their production. These laboratories contain machines and equipment that can be used to produce water cooler parts.

- Human capabilities: The General Company for Electrical Industries has many human resources with expertise and high skill, and most of them are out of work due to the suspension of most of the company's production plants.

-Raw materials that are out of stock in the warehouse sufficient to produce a large number of refrigerators developed.

From this it turns out that the issue of producing the new design for the refrigerator does not constitute a difficulty for the company in light of its technical, financial and human capabilities.

A - Has the product improved performance?

From the theoretical side, the performance of the fridge has not changed much from its previous performance except, that the use of a cooling system is based on removing the cooling tubes from the tank and making them outside the tank, will make the water obtained from the fridge more clean, in addition to the possibility of cleaning the tank.

B - The level of defects:

Certainly, the number of defects will be reduced, especially if we know that most defects were caused by:

- There is a leak (Lake) in the condenser, and the condenser was dispensed with.

- Due to the cooling pipe soldering to the length of the refrigeration cycle and the difference of pipe diameters, these were overcome through the network.

- Dispensing with the dye stage through the use of the colored pallet of the body means the final disposal of defects and losses that were caused as a result of dyeing the parts of the body.

C - Meet customer requirements:

Did the new design of the fridge three taps meet the customer's requirements? The development of the product and its new design, according

to the requirements of the customer that appeared when implementing the deployment of the quality function

(QFD), as a customer's lack of improvement in product design means wasted a lot of time and effort at work.

By referring to Table (2), which shows the relative importance of the needs of customers, we find that these needs have been met, and Table (5) explains the needs of customers and the measure taken to meet them.

Table (5) customer needs and the action taken to meet them

No.	Customer need	importance	procedure
1	container for placing drinking water cups	1	container was added to hold the mugs
2	speed in cooling the water	5	
3	water tank of suitable size	3	the same size as the tank
4	cost-effective	5	the cost was greatly reduced
5	easy to clean	2	easy Body cleaning and ease of cleaning the water tank
6	attractive external design and appropriate size	2	the ability to change the face of the fridge and make it from plastic
7	low energy consumption	4	less energy consumption
8	the presence of a water purifier	5	the possibility of adding a high-precision filter and the price of the fridge remains lower than its price before development
9	Using of suitable healthy material for the user	4	ejecting the cooling tubes outside the tank
10	ease of getting water	1	the same way to get water

Fifth: cost and duration of development:

- The company set the time required to develop the water cooler with three faucets at 45 days, but this period was exceeded until the development period reached 90 days and the period from the end of the final model tests until the delivery of the final product to the market by 45 days, but was also exceeded to 64 days. That is, a difference between the end of the final form tests and the start of production of 64 days, that this delay is due to the waiting period until the provision of raw materials, the administration's delay in taking the decision to start production.

The researcher planned to take the development process 45 days, but the development process took 47 days, including testing the final model. The product needs a period of 45 days to start its production, depending on the time required for the availability of raw materials involved in its manufacture, and this period is specified in the company with 45 days. That is, the developed product reaches the market with 95 days from the beginning of development until the final product reaches the market).

Table (6) shows the development cost, the development period, and the estimated and actual market access time in relation to the development process carried out by the company without the use of the concurrent engineering methodology, which was carried out by the researcher using the concurrent engineering methodology.

Table (6) the development cost, the development period, and the estimated and actual market arrival time, for the development process of the company and the researcher

	The development process by the company		Development process by the researcher	
the scale	The scheme	The actual	The scheme	The actual
Development cost	300,000 dinars	600,000 dinars	300,000 dinars	225,000 dinars
Development time	45 days	96 days	45 days	47 days
Time of reaching to the market	45 days	64 days	45 days	40 days

Table (7) shows all the changes that occur due to the use of the concurrent engineering methodology in the product development process.

Table (7) difference in performance between the development process by the company and the development process using concurrent engineering methodologies

Measured performance	The development process by the company	The development process using concurrent engineering methodologies	Benefit
Duration of development	96 days	47 days	Less by 51. 04%
Engineering changes	70%	90%	Higher by 28. 5%
Standard wear rates for parts production processes	21. 5%	15 %	Decrease by 30. 4%
The time from the start of the development process until the product reaches the market	160 days	92 days	Less by 42. 5%
Development cost	600,000 dinars	225,000 dinars	Less by 62. 5%
The cost of the product	323,575 dinars	193550 dinars	Less by 40. 1%
Time to market after tests are over	64 days	45 days	less by 29. 6%
selling price	400,000 dinars	300,000 dinars	Less by 25%
Expected profit	76425 dinars	106450 dinars	Higher by 39. 2%

Sixth: Simulating the development process:

In order to simulate the process of developing a water dispenser three taps, the researcher followed the following method:

1- Defining the problem:

The researcher aims to simulate the development process to obtain data that helps in conducting moral tests to measure the difference between the use of the concurrent engineering methodology, and not to use it in product development, and the impact of this on the cost of development and the

duration of development and speed of access to the market, in addition to its impact on the cost of the product, the number of parts Which is developed, the number of defects, and production time.

2- Collecting data:

The researcher has used the data obtained from the company's development of the water cooler product with three taps, and from the data achieved as a result of its development of the product, which includes the actual development costs, the actual development period, the time to reach the actual markets, the actual product costs, the number of actual parts that were included in the development, and time Production.

3- Generate random numbers:

The researcher used the computer system (Excel) to generate random numbers. Where it generated 30 random numbers using a systematic distribution method, based on the actual data obtained, and then the researcher worked with the SPSS program for the purpose of testing the hypotheses.

Seventh: hypothesis testing

To prove the validity or error of the first hypothesis of the research, a test (1) was performed according to the hypothesis of the test:

H0: μ B = μ A

H0: μ B≠ μ A

α/2 = 0. 05

μ B: The mean of the cost of the development process without using the design for DFX, DFA, DFM

μ A: The arithmetic mean of the cost of the development process using the design for DFX, DFA, and DFM and using SPSS to test (Paired Sample T - Test) results show as follows: Paired Samples Test

Sig.	df	t	Paired Differences					
			95% Confidence Interval of the Difference		Std. Error Mean	Std. Deviation	Mean	
			Upper	Lower				
000	29	- 13. 836 -	- 167862. 326 -	-226095. 607 -	14236. 367	77975. 795	- 196978. 967 -	Pair Before - 1After

Refer to the tables of the test (t) (two-sided test) at the level of significance α = 0. 05 and the degree of free (58), the tabular value of (t) is (+1.67). By reviewing the results of the tests, we find that the value of (t) has reached (-13.836) which is greater than the tabular value of (t), and that the level of significance = 0. 000, meaning that there are significant differences in the cost reduction using the design for DFX, DFA, DFM, and the development process without using these methodologies. This means that the design methods for DFX, DFA, DFM used in the development process have a significant impact on the cost of the development process, which proves the validity the first hypothesis.

- To prove the validity or error of the second hypothesis of the research, a test (t) was performed according to the hypothesis of the test:

H0: μ B = μ A

H0: μ B≠ μ A

α/2 = 0. 05

μ B: The average cost of a development process without using design for DFX, DFA, DFM μ A: The average of the cost of a development process using a design for DFX, DFA, DFM

Paired Samples Test

	Paired Differences					t	df	Sig. (2 | tailed)
	Mean	Std. Deviation	Std Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair Befor-1 After	25. 033	16. 304	2. 977	18.945	31. 121	8. 4410	29	000

Refer to the tables of the test (t) (two-sided test) at the level of significance α = 0. 05 and the degree of free (58), the tabular value of (t) is (+1.67). By reviewing the results of the tests, we find that the value of (t) has reached (-13.836) which is greater than the tabular value of (t), and that the level of significance = 0. 000, meaning that there are significant differences in the cost reduction using the design for DFX, DFA, DFM, and the development process without using these methodologies. This means that the design methods for DFX, DFA, DFM used in the development process have a significant impact on reducing the development process time, which proves the validity of the second hypothesis. To prove the validity or error of the second hypothesis for research, a test was performed (t) according to Test hypothesis:

H0: μ B = μ A

H0: μ B≠ μ A

α/2 = 0. 05

μ B: The mean of the product's market arrival time development process without using the design for DFX, DFA, DFM

μ A: The mean of the product's market arrival time in the development process using the design for DFA DFM.

The results are shown as follows: Using SPSS to test (Paired -Sample T – Test)

Paired Samples Test

					Paired Differences	t	df	Sig. (2 tailed)
	Mean	Std. Deviation	Std. Error Mean		95% Confidence Interval of the Difference			
				Lower	Upper			

Pair Befor 1 After	- 13.033-	6. 531	1. 192	-15. 472-	- 10. 595 -	- 10.930 -	29	000

Refer to the tables of test (t) (two-sided test) at the level of significance α = 0. 05 and the degree of freedom (58), the value of tabular (t) is (+ 1.67) and reviewing the results of the tests, we find that the value of (t) has reached (- 10.930) which is greater than the value of tabular (t), and that the level of significance = 0. 000, meaning that there are significant differences at the time of market access between the development process using the design for DFX, DFA, and DFM, and the development process without using these methodologies. This means that the design methods of the DFX, DFA, and DFM used in the development process have a major impact on reducing Time to reach the market, which proves the validity of the third hypothesis.

The fourth topic: conclusions and recommendations

First: the conclusions

1 - The results of the research proved that there are significant differences in reducing the cost of the product in the process in which the concurrent engineering and diffraction engineering technique is used, from the process in which these methodologies are not used and this means that the design methods of DFX, DFA, and DFM used in the development process have a significant impact on the cost .

2 - The results of the research confirmed that there are significant differences at the time of the product development process between the process in which the concurrent engineering methodology is used, from the process in which these methodologies are not used. This means that the design methods of DFX, DFA, and DFM used in the development process have a significant impact on reducing Time of the development process and this validates the second hypothesis.

3- The results showed that there are significant differences at the time of market access to the product that is being developed using the concurrent engineering methodology, from the product that does not use that methodology, the process of its development, and this means that the design methods of DFX, DFA, and DFM used in the development process have a significant impact In reducing the time the developed product reaches the market, this proves the validity of the third hypothesis.

4 - There are no precise metrics for measuring the benefit achieved from applying concurrent engineering, and the dependence on measuring it is still based on observing the rates of change before and after its application.

Second: Recommendations

1 - Given the importance of developing the products of the General Company for Electrical Industries, and the fact that a number of products have once a long time since starting to produce them and have not been subject to any development process, and the role of the concurrent

engineering methodology in developing the product, the researcher believes that it is necessary for the company to use this methodology in developing its products.

2 - For specialized computer software, GRAPH SOFT, SOLID WORKS, 3DMAX CAD and others an active role in helping to design products and this is what most companies resort to. Therefore, it is more appropriate for the General Company for Electrical Industries to rely on such software in designing and developing its products.

3 - The General Company for Electrical Industries has large idle energies. The researcher recommends that it be used to produce multiple types of water coolers, or to produce other products.

4 - Concurrent engineering has a great role in reducing the time of the developed product reaching the market. Therefore, the employees must be familiar with and familiar with these methodologies, and the importance of their application in the company.

5 - The work team is the basis for the success of the product development process using the CE concurrent engineering methodology; therefore the researcher recommends that the General Company for Electrical Industries should rely on the work team of various jobs in the company when developing its products.