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Flexible Manufacturing System Environments and Their Role in Achieving Competitive Superiority: A field study in the General Company for Electrical and Electronic Industries

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ABSTRACT: The labor market has become rapidly moving and changing as a result of the change in customer tastes on the one hand, and the products offered by competing organizations, so it is necessary for the organization to move towards using a flexible manufacturing system that works in all environmental changes to be able to achieve customer satisfaction and outperform competitors in the market. On this basis, the main objective of this study is to find the role of flexible manufacturing system environments in enhancing competitive superiority over others in the labor market. To achieve this objective, the study sample factory was visited in order to learn about the production and marketing method. In light of this, a questionnaire form was designed according to the five-point Likert scale in order to collect data on the study variables. The forms were distributed to 60 of the company's engineers and administrators. After collecting and analyzing the data using the program (MINITAB. V18), and based on the analysis results, the study reached a set of conclusions and proposals.

Keywords: Flexible manufacturing, competitive advantage, electrical industries

I. INTRODUCTION:

Today business organizations are working hard to achieve customer satisfaction by providing products that meet their desires and achieve their happiness, in addition to the organizations' efforts to control the labor market by outperforming competitors. This requires that these organizations have a flexible manufacturing system characterized by agility in the process of processing and assembling the product and in a manner that suits the different requirements of customers, in addition to the speed of response to these requirements. This will achieve competitive advantage for the organization at the expense of other organizations.

The General Company for Construction Industries in Iraq, one of the government companies, seeks to apply the flexible manufacturing system in all its production and marketing activities in order to confront local and international competitors, as the company provides many construction products that are produced according to quality specifications 9001, but its products do not cover the needs of the local market, which makes competitors easily enter the market and control it. The company, the study sample, seeks to adopt a flexible production system that combines large-scale production and production according to customer demand, with the aim of improving its financial performance and outperforming competitors in the Iraqi market.

Study Methodology

The study problem:

The General Company for Construction Industries in Iraq faces many problems that prevent the application of the flexible manufacturing system in all its production and marketing activities. These problems include: First: The lack of financial resources necessary to invest in flexible manufacturing technologies. Second: The Company does not have sufficient experience in the field of applying flexible production technologies, which requires training programs outside the country. Third: The Iraqi Ministry of Industry does not have the seriousness to apply flexible manufacturing technologies in all Iraqi companies. This is due to the weakness of the ministry's management and its lack of a clear vision on the subject. These three problems will undermine the efforts of the study sample company in production, marketing and competitiveness, and make it a traditional company that keeps pace with development very slowly. To solve this problem, the following questions were raised:

1- Does the company have a clear idea about the environments for applying flexible manufacturing?
2- How does the study sample company achieve competitive superiority over others?

3- What is the relationship and impact of flexible manufacturing environments in enhancing marketing superiority?

Study objective:

The main objective of this study is to find the role of flexible manufacturing system environments in enhancing competitive superiority. To achieve this objective, it is necessary to study all the problems that prevent the successful implementation of the flexible manufacturing system in the study sample company, and to address these problems based on the theoretical and field aspects of the study in order to reach the desired objective of the study, which is enhancing competitive superiority over others.

Study hypotheses:

The current study is based on one hypothesis: The first main hypothesis: There is a significant influence relationship for flexible manufacturing environments on competitive superiority. From this hypothesis, the following sub-hypotheses emerge:

H1.1: There is a significant influence relationship for the life cycle environment on competitive superiority.
H1.2: There is a significant influence relationship for marketing and time on competitive superiority.
H1.3: There is a significant influence relationship for the assembly environment on competitive superiority.
H1.4: There is a significant influence relationship for the processing environment on competitive superiority.

Theoretical Framework

What is flexible manufacturing?

The term "Agile Manufacturing" was originally coined in an important report entitled "Strategy for the Manufacturing Organization in the 21st Century" drafted by the Iacocca Institute at Lehigh University in the United States of America in 1991. In this report, the phrase "Agile Manufacturing" described a unique form of industrial competition for American companies, where changes may occur in the roles of customers, suppliers and competing companies to take advantage of opportunities in the market in order to meet individual customer preferences (Kumar, et. al, 2022, 2). Flexible manufacturing is defined as the successful exploration of competitive rules (speed, flexibility, proactivity, innovation, quality and profitability) by integrating reconfigurable resources and best practices in a knowledge-rich environment to provide customer-driven products and services in a rapidly changing market environment (Elbaz, 2021, 1). It can be said that flexible manufacturing is the ability to adapt and respond to rapid changes, whether in technological changes, government policies or customer specifications, in order to provide products with better quality, higher reliability and faster delivery to meet competitive pressures.

II. FLEXIBLE MANUFACTURING ENVIRONMENTS:

(Shewchuk, J, 1998) classified four flexible manufacturing environments that are expected to be applied in the near future, and these environments are:

1- The compressed life cycle environment: Technological changes and increasing competition have put contemporary organizations under tremendous pressure to bring new products and market them quickly, which requires a large investment, short time, and making different decisions during the production process and enhancing basic research and development capabilities, which has made the product life cycle environment compressed (Ganguly, et. Al, 2013, 25). The flexibility of the compressed life cycle environment can be defined as the organization's ability to adapt and redesign its market offerings quickly in response to market changes to achieve sustainable competitive advantage. The compressed environment is characterized by dynamism as a result of rapid market changes, resulting from the actions of consumers, governments, suppliers, strategic partners and competitors. It is necessary to choose the right time to launch new market offerings (Arnett, et. Al, 2018, 287). The compressed life cycle environment is characterized by medium product diversity and high demand for the product During the maturity stage of a product's demand, short product life cycles, by introducing new features so quickly that new products quickly become obsolete. Examples of products in this environment include home computers, audio equipment, and cameras, and thus this environment can be referred to as a compressed life cycle environment (Shewchuk, 1998 , 146).

2- The compressed marketing environment and time: Global organizations have become fast and operate in an uncertain and complex environment. Organizations must have a flexible system that applies to all their activities in order to quickly adapt to market requirements to meet short- and long-term demand fluctuations, as well as deal with threats that they may face in the changing business environment. Therefore, the flexibility of the compressed marketing environment will achieve success and survival for the organization in the market on an ongoing basis (Gopakumar and Suresh, 2020, 1). In addition, the success of the marketing environment depends on: expanding the volume of production to meet market demand, expanding the boundaries of the production system to provide diverse products, working to integrate market effects with consumer and product behavior, changing external market effects through sensitivity or variance analysis over time, and reaching the

market in the shortest possible time. The short time is what causes the marketing environment to be compressed. It is necessary to achieve a balance between short time and marketing flexibility (Whitefoota and Skerlosb, 2016, 337).

3- Mass customization via assembly environment: Mass customization is the use of flexible computer-aided manufacturing systems to produce customized outputs in a mass production environment. The main purpose of this strategy is to combine the low unit costs of mass production with the flexibility of individual customization. It allows customers to interact directly with the product during the time of product production or design, allowing the manufacturer to meet the customer's specific needs (Barman, 2013, 2). The flexible assembly environment is a series of multi-use workstations connected to an automated material system. Automated material handling has been emphasized as an important part of flexible assembly systems. The ability to handle different product variants in the same assembly system is important in flexible assembly systems (Asadi, 2017, 12). The relationship between mass customization and the product assembly environment is very closely related. When adopting the mass customization approach, this requires providing a flexible and adjustable production system that allows the manufacturing process to be adapted to meet different customer preferences. In addition, providing and providing a product assembly environment is an essential part of this system, in which products are assembled based on demand. The product assembly environment that supports mass customization requires equipping production lines with versatile tools and equipment that allow the manufacture of different products, in addition to modifying and adapting these tools and equipment based on the individual request of each customer (Dutta and Mandal, 2019, 453).

4- Mass customization through the processing environment: Mass customization refers to the ability to efficiently produce customized products on a large scale, while integrating the benefits of both mass production and customization. It also involves offering customers a range of customizable options while still achieving the economies of scale associated with mass production. The processing environment involves designing production processes that can accommodate the variability and customization requirements of individual customer orders. This requires flexible and adaptable manufacturing systems that can efficiently handle different customization options and quickly switch between product configurations. The processing environment facilities must be integrated, such as providing multiple equipment and production lines and using advanced technologies such as computer-aided design and manufacturing (CAD/CAM), flexible automation systems, standardized production settings, and efficient supply chain management (Pine and Gilmore, 1998, 100). The relationship between mass customization and the production processing environment relates to how the production processing environment affects a company's ability to successfully achieve mass customization. The production processing environment plays a critical role in the success and effective realization of mass customization. The production processing environment includes factors related to the production processes, systems, and technology used in manufacturing products. Achieving mass customization requires Adapting the production processing environment to suit the diverse customization requirements of customers, by designing the production processing environment correctly by investing in appropriate technology and automation (Peck and Teixeira, 2019, 1393).

Competitive superiority:

It is the organization's investment in its internal capabilities and distinguished efficiency in providing products that outperform competitors and exceed customer expectations by providing innovative products to reach the highest levels of customer satisfaction (Abbas and Yunus, 2023, 146). (Al-Dawudi and Saleh, 2020) define it as the organization’s ability to outperform competitors by satisfying customer needs. Competitive superiority is achieved through the following dimensions:

1- Cost: It refers to the organization's ability to implement at the lowest costs compared to the ability of competitors, and this is done by improving productivity and efficiency, eliminating waste, and strict control over costs. Competition is largely derived from reducing costs related to raw materials or the use of workers (Al-Naimi and Al-Afandy, 2017, 203).

2- Quality: It is considered as a work plan to produce and provide a product or service that is confirmed with the needs or requirements of customers by processing better, cheaper, faster, safer and easier than competitors with the participation of all working individuals (Hamad, 2022, 365). (Hussein, 2016) explains quality management as a set of standards on the basis of which the product is produced. And the continuous improvement of that product so that the organization can remain in the market with excellence.

3- Creativity and flexibility: It is the creation of new ideas far from the traditional context of thinking and the development of all methods and approaches that would transform these ideas into an applied reality with useful value for society, bearing in this all forms of adventure represented by change and support processes to achieve organizational goals (Al-Naimi and Al-Afandy, 2017, 203), while flexibility is the company's ability to transform from one product to another or from one customer to another with the least possible costs and delays, and flexibility includes: First: Flexibility of size: The company's ability to change production rates by

increasing or decreasing each product, Second: Flexibility of workers: The company has workers with multiple skills through which different tasks can be carried out (Raouf and Al-Shahwani, 2020, 306).

4- Delivery: It is known as the best way to deliver the product or service to the customer, which includes speed, accuracy, and care in the delivery process (Raouf and Al-Shahwani, 2020, 306).

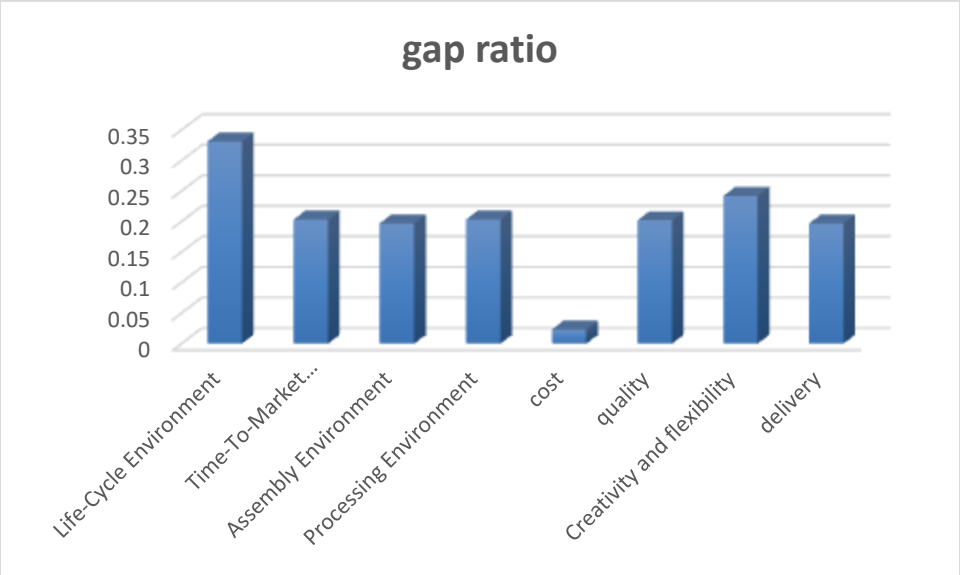
III. FIELD FRAMEWORK

The general indicator of flexible manufacturing results: The results of Table (1) indicate that the individuals in the study sample agreed that their company's management is constantly trying to apply flexible manufacturing environments in all its operations in order to achieve competitive superiority in the field of work, as indicated by the arithmetic mean and estimated (3.830), which is a good rate because it is higher than the hypothetical arithmetic mean estimated (3), while the standard deviation formed a percentage (1.004), while the conformity or response percentage was (76.6%), which is a high percentage indicating a high level of awareness among the company's employees about the importance of applying flexible manufacturing techniques and its great impact in enhancing competitive superiority. The gap also obtained a percentage of (23.4%), which is a low and acceptable percentage. This percentage shows the percentage of employees who do not agree to apply the study topic in the company, which means that (76.6%) of the individuals completely agree on the necessity of applying flexible manufacturing in the company. Therefore, we advise the company's management to apply flexible manufacturing techniques in its work environment to reach the highest levels of quality and achieve customer satisfaction. Second: The general indicator of competitive superiority results: The results shown in Table (1) indicate that the working individuals agreed that their company's management seeks to achieve competitive superiority in the labor market in a sustainable manner by knowing the customer's need and providing that need in a way that achieves customer satisfaction and loyalty and enhances its value, as indicated by the arithmetic mean and estimated (4.165), which is a good rate because it is higher than the hypothetical arithmetic mean estimated (3), while the standard deviation formed a percentage of (0.933), while the conformity or response percentage was (83.3%), which is an excellent percentage, which shows a high level of awareness among the company's employees about the importance of achieving customer satisfaction to enhance competitive superiority, while the gap formed a percentage of (16.6%), which is a low and acceptable percentage, as this percentage shows the percentage of employees who oppose the application of competitive superiority requirements in the company, which means that (83.3%) of individuals completely agree on the necessity of applying the conditions of competitive superiority in the company, so we call on the company's management to pay attention to the requirements of competitive superiority in its work environment to reach the highest levels of satisfaction Customer and gaining his loyalty and enhancing his value.

Table (1) The general index of the arithmetic mean, standard deviation, conformity ratio and gap ratio for employees' answers about flexible manufacturing and competitive superiority.

Study variables	mean	st. dev	matching ratio	gap ratio	N
Compressed Life-Cycle Environment	3.344	1.162	0.668	0.331	**60**
Compressed Time-To-Market Environment	3.984	0.989	0.796	0.203	**60**
Mass customization Via Assembly Environment	4.011	0.882	0.802	0.197	**60**
Mass customization Via Processing Environment	3.981	0.984	0.796	0.203	**60**
flexible manufacturing rate	**3.830**	**1.004**	**0.766**	**0.234**	
cost	4.885	0.821	0.977	0.023	**60**
quality	3.988	0.998	0.796	0.202	**60**
Creativity and flexibility	3.786	1.033	0.757	0.242	**60**
delivery	4.011	0.882	0.802	0.197	**60**
competitive advantage rate	**4.165**	**0.933**	**0.833**	**0.166**	

Based on the above results, we embody the gap percentage in the answers of the individuals working in the company in Figure (1), as it was shown that the life cycle environment achieved the highest gap percentage, estimated at approximately (33%), followed by the creativity and flexibility gap at (24.2%), followed by the time and marketing gap, the processing environment gap, and the quality gap at (20.3%), reaching the lowest gap percentage, which is represented by cost, which achieved a percentage of (2.3%). The purpose of using this figure is to provide a detailed picture of the percentage of employees who oppose the application of flexible manufacturing techniques in the company in all its dimensions, as well as opposition to enhancing competitive superiority through flexible manufacturing. Figure (1) The gap percentage in employees' answers to the study variables.



Hypothesis Testing:

This paragraph deals with testing the study hypotheses as follows:

1- The relationship of the impact of flexible manufacturing environments on competitive superiority: It is clear from the results of Table (2) that flexible manufacturing environments affect competitive superiority by a percentage of (0.480), which indicates the significance of the effect, in terms of the calculated T-test value (22.2), this effect is significant, which means that changing flexible manufacturing by one unit will lead to an increase in the value of the dependent variable (competitive superiority) by (48%) with the rest of the variables constant, and the validity of the model may also be proven through the R2 value, which is (0.649), which is a significant value according to the calculated F value (30.2), which is a significant value, and this means that (64.9%) of the change in the dependent variable (competitive superiority) is a result of the independent variable, and this leads to accepting the first main hypothesis, which states (the existence of a significant relationship of impact of flexible manufacturing environments on competitive superiority).

2- The impact relationship of the compressed life cycle environment on competitive superiority: The results of Table (2) indicate the existence of a significant impact relationship of the compressed life cycle environment on competitive superiority, as indicated by the R2 value of (0.581), which is a significant value according to the calculated F value (28.1), which is a significant value. This means that (58.1%) of the change in the dependent variable (competitive superiority) is a result of the independent variable. To confirm the validity of these results, test (B1) was conducted, which indicates the existence of a significant impact relationship of the compressed life cycle environment on competitive superiority at a rate of (0.430). This indicates the significance of the effect, as indicated by the calculated T-test value (19.8), this effect is significant. This means that changing the compressed life cycle by one unit will lead to an increase in the value of the dependent variable (competitive superiority) by (43%) with the rest of the variables being constant. This leads to accepting the first sub-hypothesis, which states (the existence of a significant impact relationship of the compressed life cycle environment on competitive superiority).

3- The impact relationship of the marketing environment and compressed time on competitive superiority: The results of Table (2) show that the marketing environment and compressed time have a significant impact on competitive superiority at a rate of (0.523), which indicates the significance of the impact, as indicated by the calculated T-test value (24.6), this impact is significant, which means that changing the marketing environment and compressed time by one unit will lead to an increase in the value of the dependent variable (competitive superiority) by (52.3%) with the rest of the variables constant, and the validity of the model may also be proven through the R2 value, which is (0.706), which is a significant value according to the calculated F value (32.4), which is a significant value, and this means that (70.6%) of the change in the dependent variable (competitive superiority) is a result of the independent variable, and this leads to accepting the second sub-hypothesis, which states (the existence of an impact relationship between the marketing environment and compressed time on competitive superiority).

4- The impact relationship of comprehensive allocation through the assembly environment on competitive superiority: The results of Table (2) show the existence of a significant impact relationship of comprehensive allocation through the assembly environment on competitive superiority, indicative of the R2 value of (0.641), which is a significant value according to the calculated F value (29.8), which is a significant value. This means that (64.1%) of the change in the dependent variable (competitive superiority) is a result of the independent

variable. To confirm the validity of these results, test (B1) came, which indicates the existence of a significant impact relationship of comprehensive allocation through the assembly environment on competitive superiority at a rate of (0.475), which indicates the significance of the effect. Indicative of the calculated T-test value (21.8), this effect is significant. This means that changing the comprehensive allocation to the assembly environment by one unit will lead to an increase in the value of the dependent variable (competitive superiority) by (47.5%) with the rest of the variables being constant. This leads to accepting the third sub-hypothesis, which states that (there is a significant impact relationship of comprehensive allocation through the assembly environment on Competitive superiority).

5- The relationship of the impact of comprehensive customization across the processing environment on competitive superiority: The results of Table (2) indicate that there is a significant impact relationship for comprehensive customization across the processing environment on competitive superiority, at a rate of (0.494), which indicates the significance of the effect, in terms of the calculated T-test value (22.7), this effect is significant, which means that changing the comprehensive customization of the processing environment by one unit will lead to an increase in the value of the dependent variable (competitive superiority) by (49.4%) with the rest of the variables constant, and the validity of the model may also be proven through the R2 value, which is (0.668), which is a significant value according to the calculated F value (31.3), which is a significant value, which means that (66.8%) of the change in the dependent variable (competitive superiority) is a result of the independent variable, which leads to accepting the fourth sub-hypothesis, which states (the existence of a significant impact relationship for comprehensive customization across the processing environment on competitive superiority).

Table (2) Correlation and impact relationships for flexible manufacturing environments and competitive superiority in the company

Variables	**Correlation and regression analysis**						
	competitive advantage						
	B_1	T-test	P - value	R^2	R	F - test	**DF**
Agile manufacturing	0.480	22.2	0.000	0.649	0.805	30.2	**1 - 59**
Compressed lifecycle environment	0.430	19.8	0.000	0.581	0.762	28.1	**1 - 59**
Marketing and time environment	0.523	24.6	0.000	0.706	0.840	32.4	**1 - 59**
Assembly Environment	0.475	21.8	0.000	0.641	0.8007	29.8	**1 - 59**
processing environment	0.494	22.7	0.000	0.668	0.817	31.3	**1 - 59**

IV. CONCLUSIONS AND RECOMMENDATIONS

Conclusions:

1- The results of the general index of the arithmetic mean indicate that the individuals working in the company agree at a high rate on the application of flexible manufacturing techniques in the company's internal and external environment in general, as the arithmetic mean rate reached (4.172), which is higher than the hypothetical mean, and this indicates a positive result.

2- The study revealed that competitive superiority achieved the highest arithmetic mean from the answers of the company's employees, as it formed a value of (4.233), which shows that the company is able to achieve competitive superiority in the Iraqi local market at least, while the compressed life cycle environment variable, one of the dimensions of flexible manufacturing, obtained the lowest arithmetic mean, estimated at (3.984), which shows that the company has a product life cycle, but it is somewhat compressed, meaning that the company needs long periods of time to introduce a new product.

3- The study concluded that the response rate or conformity rate was high (83.4%), which indicates the high level of awareness of employees about the importance of applying flexible manufacturing technologies to all company activities.

4- The results of the study show that the gap rate is very low (16.5%), which explains the low percentage of employees who oppose the flexible manufacturing issue, compared to the high response rate of employees in the company who want to apply flexible manufacturing requirements in order to achieve competitive superiority in the market.

5- The results of the multiple regression indicate that there is a statistically significant moral influence relationship for the independent variable (flexible manufacturing) in all its dimensions on competitive superiority, which led to accepting all study hypotheses.

Recommendations:

1- Work on investing in automated technologies that would help the company provide products according to customer demand and with the appropriate quality and time, by providing sufficient financial allocations.

2- Developing the skills of the company's employees to use flexible technologies by holding workshops for them or holding periodic training programs to be more experienced and skilled in dealing with flexible manufacturing.

3- The necessity of sharing customers' ideas in the production process in order to provide products that meet their desires and achieve their happiness, and this will be reflected positively on the company's performance in general and achieve competitive superiority for the company in particular.

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