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| RESEARCH ARTICLE

Analysis of the Dimensions of Lean Manufacturing through the Hierarchical Analysis Process in the General Company for Automobile and Equipment Manufacturing in Alexandria, Babylon of Iraq

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| ABSTRACT
This study analyzed the dimensions of agile manufacturing through a hierarchical analysis process at Alexandria's State Company for Automotive and Equipment. This topic is important in the use of management accounting methods as means to improve the performance of automotive and equipment manufacturers in Alexandria, with a view to achieving their objectives. The fact that these companies also have a significant and fundamental impact on the realities of Egypt's economy was the answer to the following questions: What are the elements of agile manufacturing at Alexandria's State Automotive and Equipment Company? What are the most relevant dimensions of the company's agile manufacturing? And the researcher has followed the analytical approach of analyzing the data on research that will be obtained through the study tool of the scale of dimensions of agile manufacturing, The research was based on the collection of data related to the search on the personal interview with members of the company's senior management to obtain information and data and relying on the lean manufacturing scale 2012 Singh & Culshan which consists of nine dimensions and applied to employees of the Automotive and Equipment Industry Company in Alexandria, One of the results of this study is a hierarchical analysis process, which depends on the opinions and ideas of the people involved in issuing judgments only, but not other employees of the company, and therefore the views of as many employees as possible must be expanded. In Alexandria, there is an average value for agile manufacturing. Interest from Alexandria General Automotive Company's management in achieving agile manufacturing and the study recommended that attention should be paid to low relative weight dimensions and to high relative weight dimensions and maintain this level to be used in the implementation of agile manufacturing, Raising the level of awareness of the employees of the State Automotive Company in Alexandria of the importance of applying and increasing the level of efficiency of the dimensions of the process of agile manufacturing and providing all the possibilities and needs required by the process of agile manufacturing.

| KEYWORDS

Lean manufacturing- hierarchical analysis- Automobile and Equipment Manufacturing

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1. Introduction

1.1 General framework of the study

Lean manufacturing is a common concept at the level of global industrial organizations that aim to survive and continue in light of the great pressures in order to improve quality and productivity and reduce costs, and because of the high competition and the widespread the interest in preserving environmental resources for future generations, lean manufacturing has adopted As a new system of production to improve its fields of work, increase its profits, exploit its resources and maximize its outputs, lean manufacturing has evolved from lean thinking to reducing or eliminating wastes, which specifically means reducing any resource activity that does not add value, and the added value is through eliminating seven basic types of losses. (Overproduction - unnecessary movements of the worker and machine - waiting - processing method - transportation - stock - rework) (Mahdi, p. 112).

The Lean manufacturing philosophy application is one of the concepts that help organizations gain a competitive advantage in global markets. Many types of research indicated that there are positive correlations between the combined foundations of Lean manufacturing and sustainable competitive advantage at the organization level. Lean manufacturing or lean production is considered a practice of Productivity. The use of resources for any work other than creating value for the end customer is considered a waste, although many companies are starting to implement the concept of lean manufacturing, and the number of tools and lean techniques available to improve operational performance is increasing rapidly, but 10% or less of companies have achieved significant results, In order to maintain competitiveness in the market, the company must understand the needs of its customers and design specific processes to meet their expectations and requirements (Mady, 2020).

The current research aims to measure and analyze the dimensions of lean manufacturing in the General Company for Automobile and Equipment Manufacturing in Alexandria, where the case study method was used to reach the objectives of the research. A number of quantitative tools were utilized to analyze the data, and the researcher concluded a number of results and recommendations.

1.2 Study Problem

The research problem is represented in the lake of technological and Informatics capabilities in industrial companies to use and introduce new industrial philosophies that enable them to face high competition with other companies, thus enhancing their competitive position in the local and global markets, accessing foreign markets and achieving optimal utilizing of resources.

In light of these changes, industrial companies are subjected to pressures to improve productivity, reduce costs, improve product quality, and preserve the environment and its resources. This leads to the production of high-quality products at an appropriate economic cost.

Hence, the study problem can be formulated in the form of a set of questions as follows:

1. What is the availability of the ingredients of lean manufacturing in the General Company for car and equipment manufacturing in Alexandria?
2. Does the General Company for Car and Equipment Manufacturing in Alexandria have a vision and interest in the dimensions of lean manufacturing?
3. What are the most relevant dimensions to achieving lean manufacturing in a company?

1.3 Study Objectives.

This current research aims to achieve the following objectives:

1. Investigating the availability of the ingredients of lean manufacturing in the General Company for car and equipment manufacturing in Alexandria?
2. Determine the contribution degree of each dimension of Lean Manufacturing dimensions and determine the most relevant dimensions to achieve Lean Manufacturing.

1.4 Study Importance.

The importance of the study comes from the importance of using management accounting methods as a tool to improve the performance of cars and equipment manufacturers in Alexandria (the case of the study), to help the company to achieve its goals, and because these companies also have a significant and fundamental impact and role on the reality of the Iraq economy.

The importance of the research can be represented by achieving the following:

1. Attempting to draw the attention of the General Company for cars and Equipment Industry in Alexandria to the process of lean manufacturing in its various dimensions, which contributes to eliminating some types of waste in the production process and improving quality.
2. Attempting to identify the most related and consistent dimensions in achieving the lean manufacturing process in the company by adopting the hierarchical analysis method, and this provides quantitative indicators that benefit the company's administrative leaders by investing their capabilities in managing their operations towards achieving lean manufacturing.

2. Research Methodology

The research uses the analytical method, which is concerned with analyzing the data related to the research, which will be obtained through the study tool represented in the Lean Manufacturing Dimensions Scale.

2.1 Data collection methods

The research relied on the following in collecting data related to the research:

1. Personal interview with senior management personnel in the company to obtain information and data.
2. Lean Manufacturing Scale (Culshan & Singh, 2012) consists of nine dimensions (elimination of waste, continuous improvement, zero defects, on-time delivery, raw material recall, multi-functional teams, decentralization, job integration, and vertical information systems).

2.2 Analysis tools and processing

The research relied on the hierarchical analysis process, which includes making binary comparisons, preparing the natural matrix, and calculating the weight of each dimension of Lean Manufacturing through a set of equations.

2.3 Study limitations

Geographic limitations: Manufactures cars and equipment companies in Alexandria.

Objective limitations: Lean Manufacturing, Hierarchical Analysis.

Time limitations: The study was conducted in the second semester of the academic year.

Human limitations: Workers in the cars and Equipment Manufacturing Company in Alexandria.

3. Theoretical framework and previous studies

This chapter includes two main parts, the theoretical framework of the study and previous studies. The first part (the theoretical framework) contains the concept and definition of Lean Manufacturing, Lean Manufacturing requirements, Lean manufacturing success factors, Lean manufacturing system characteristics and benefits, and types of waste in the Lean manufacturing system, while the second part contains previous studies related to the subject of study, both Arab and foreign, And contains a kind of compression between the current study and previous studies explaining the similarities and differences.

3.1 Theoretical framework

3.1.1 The concept and definition of Lean Manufacturing

Lean Manufacturing is considered one of the modern administrative concepts that are based on a set of ideas and principles that any industrial organization can adopt in order to achieve the best possible performance. The writers and researchers provided many definitions of the concept of Lean Manufacturing, just like other administrative concepts, and these diversifications of provided definitions are due to the different points of view and the objectives of using this concept, discussing and treating it from more than one perspective. But all authors emphasize that Lean Manufacturing aims, in its final vision, to eliminate all kinds of waste in the manufacturing process and improve the manufacturing performance of the industrial organization (Al-Hamiri, 2020, p. 20).

Taigchi Ohno was the first one who invented methods of lean manufacturing, and he was one of the engineers working in the Japanese company Toyota when he realized that the areas allocated for production in Japan are a scarce resource due to the small space of Japan, which prompted him to invent ideas to reduce losses in all its forms and types. One of the specialized institutes wrote a book entitled "The Machine that Changed the World" to explain the success of Toyota by using a production system that eliminates all forms of waste in operations, then known as Lean Manufacturing. Over the past two decades, researchers have developed a definition for understanding Lean manufacturing and have proposed that it can be at two levels (Reid, 2002):

1. At the strategic level, how to understand the value.
2. At the operational level and how to eliminate losses.

Accordingly, Lean Manufacturing has been defined as an integrated production philosophy based on eliminating waste and continuous improvement of the processes through which the largest amount of output is obtained with the least amount of inputs, low or no storage levels of materials and production, and fewer workers (Al-Hamiri, 2020, p. 38).

Lean manufacturing can also be defined as an integrated set of activities designed to achieve production using the least possible stock of raw materials, semi-finished and under-processed materials, and finished goods (Mahdi, p. 116).

(Wahab et al., 2013) stated that the word lean refers to lean manufacturing, but it uses less of everything compared to mass production, using only half the human effort, half the manufacturing space, half the investment in tools, and half the engineering hours to develop a new product.

In the light of the above, the researcher finds that the different definitions of lean manufacturing are related to the different opinions about which characteristics are related to the concept, and this causes confusion at the theoretical level, which may lead to greater confusion at the practical level.

(Mahdi, p. 116) stated that Lean Manufacturing means delivering the products or services to the customer in the exact quality, quantity, and time required and at the lowest cost whenever possible. Lean manufacturing is also defined as a system that eliminates waste and activities that do not add value to every part of operations and business.

There are also those who believe that the Lean Manufacturing system is based on the philosophy of economy in resources as the main focus for production processes, but without compromising the required quality level (Wilson, 2010: 45).

Lean manufacturing has been widely implemented in manufacturing companies around the world. However, the low success rate of lean transformations in many countries has raised concern, and the researchers pointed out that the main reason is the failure to manage the change process during the transition to lean manufacturing. (Agus, 2012).

From the above discussion, we can say that researchers look at Lean Manufacturing from several aspects that differ according to each researcher's point of view, as it is a philosophy, an approach, and a system, but all of them agreed that lean manufacturing focus on waste elimination of activities that do not add value to the process, and then the organization would be able to improve areas of its work, increasing its profits, exploiting its resources and maximizing its outputs.

3.1.2 Lean Manufacturing Requirements

Lean manufacturing has many requirements, and some call it "tools'' that all seek to continuously improve processes and eliminate all kinds of waste. These requirements are (Mahdi, p. 117):

1. Organizing and arranging the workplace.
2. Value stream map.
3. Continuous improvement.
4. Reduce setup time.
5. Quality tools.
6. Withdrawal systems.
7. Comprehensive production maintenance.

3.1.3 Principles of Lean Manufacturing

In order to achieve the main goals of industrial philosophy for projects, it must be based on a set of basic principles. Jeffrey Liker, in his book "The Toyota Way," provided fourteen principles for Lean Manufacturing philosophy, which are: (Japa, 2017, p. 180):

1. Principle One: Focus the organization's explanatory decisions on a long-term philosophy and acceptance of short-term costs.
2. The second principle: creating a continuous flow in the operations of the institution in order to face problems.
3. The third principle: adopting a system of withdrawal instead of payment in order to avoid extra production.
4. The fourth principle: streamlined activities by operations facilitating and bureaucracy.
5. The fifth principle: Emphasis the institution culture-based stop production when needed and at the appropriate time in order to address problems and ensure a good level of quality from the first batch of production.
6. Principle Six: Describe and control the production processes and follow the continuous improvement rule.
7. The seventh principle: visual management, meaning that all the rules and facilitating methods should be clear to everyone and known to everyone in order to keep the mistakes discovered and not hidden.
8. The eighth principle: Using only proven technology in the production process in order to avoid making mistakes and wasting time and resources.
9. The ninth principle: Creating leadership people who are sufficiently familiar with the details of all operations within the organization and who are able to dedicate and emphasize the culture and philosophy of the organization in their own way.
10. The tenth principle: creating work teams specialized in quality that follows the philosophy of the institution.
11. The eleventh principle: Respecting partners and suppliers and encouraging them to keep always developing and improving.
12. The twelfth principle: Dedicating the fieldwork in order to understand exactly what is going on and understand the real situation correctly.
13. The thirteenth principle: Deliberateness in decision-making and cooperation with the related parties within the institution, and taking into account all the surrounding factors.

14. The fourteenth principle: The organization must always stay on the learning approach, track the causes of the organization's problems, and work to solve them through continuous improvement.

3.1.4 Lean Manufacturing Success Factors

The success of Lean Manufacturing depends on the following factors (Mahdi, p. 117):

1. The commitment of senior management to transition to Lean Manufacturing, and determining the requirements for this transition, emphasizing the participation of senior management in the process, determining the transition costs, how long it takes, and the expected results from it.
2. Obtaining cooperation and support from employees and preparing all training programs that include courses in equipment preparation and maintenance and training to perform many tasks, cooperation and solving problems facing work, and ensuring that employees are fully aware of what Lean manufacturing is and why the organization wants to switch to it.
3. Reduce the number of preparation times while maintaining the current system with a gradual transition process and prepare workers to identify and solve existing problems related to the lack of quality.
4. Study the processes carefully and determine which parts need more effort to move to Lean Manufacturing.
5. The organization should be ready to face the obstacles that stand without trying to move to the Lean maintaining philosophy.
6. Adopting a gradual transition process in operations from the end of the process and back-end work, ensuring its success, and not starting to reduce inventory until the main problem is resolved.
7. Integration with suppliers by converting them to Lean manufacturing and identifying those who are fully prepared to work according to the Lean manufacturing philosophy, preferring suppliers who have records and long-term dealing with marketing, using nearby suppliers to ensure a quick response, establishing a long-term commitment with them and insisting on high-quality levels and fixed delivery times.

3.1.5 Stages of Lean Manufacturing Application

Al-Azab (2016, p. 429) mentioned that the lean manufacturing process goes through a number of stages, which are:

1. Stability
2. Continuous flow
3. Development or standardization of work
4. Pulling system
5. Output level
6. Continuous improvement

Lean Manufacturing System Characteristics:

Lean manufacturing is characterized by a number of characteristics that distinguish it from other manufacturing systems. A number of authors and researchers refer to a group of characteristics that characterize the organization in order to describe the lean manufacturers, and these characteristics are as follows (Susan, 2016):

1. Reducing the space required for storage by reducing the space for moving parts.
2. Developing the workforce and improving business design consistently, focusing on training, employee participation, and commitment, and promoting teamwork.
3. Develop relationships with suppliers and help them understand their needs.
4. Teaching suppliers to take responsibility, helping them meet the needs of customers.
5. Reducing the number of business types and working on building worker flexibility.
6. Establishing systems that help workers produce perfect parts every time.
7. Struggle to constantly reduce costs.

3.1.6 The benefits of the Lean Manufacturing System

Mahdi indicates that lean manufacturing focuses on eliminating continuous waste and thus achieves a set of benefits, which can be summarized as follows:

1. Increasing the productivity of workers.
2. Make good use of the work space.
3. Optimal utilization of energy and equipment.
4. Increase profits.
5. Quality improvement.

6. Reducing waiting time.
7. Reduction of in-progress stock.

3.1.7 Forms of Wastage in the Lean Manufacturing System

The various forms of waste that may face any production process are represented in the following (Jaba, 2017, p. 182):

1. Overproduction

According to the Lean Manufacturing System, excess production is the production that exceeds the demand or the production that is not sold immediately after production. This type of production causes a waste of space and financial resources for the institution.

2. Waiting time

the lost time that can be caused by a bad flow in the production line due to the waiting for a certain period before processing, the worker waiting for the materials to arrive at the work center, or the machine's breakdown and stopping for a certain reason, in addition to the stops caused by production stops due to changing a certain mold in order to start the process of preparing or creating a new production process.

3. Handling time

It is the time that is wasted in internal movements within the organization between work centers or between different workshops; the Lean Manufacturing system works to reduce the spaces between these centers and also works to reduce the number of times the worker takes or puts materials without adding value to the production process.

4. Poor preparation of the production process

This happens because of the classic techniques that the engineer uses to prepare for the production process; Lean Manufacturing focuses on the idea of developing a description of all stages and processes for preparation in a way that makes everyone work in the same way, using methods and techniques adapted to modern technology, which allows a good adaptation with the nature of the production process and determining the cost accurately.

5. Inventory

Stored units are a waste of money and need space and additional costs in order to maintain it, so this type of expense must be eliminated.

6. Unnecessary movement

This type of waste has the same nature as waste from handling and includes all the movements of the worker in the work center. This leads to a waste of effort and time, and therefore the organization must organize the workplaces in a way that makes the tools that the worker constantly uses close and the tools he rarely uses in a further place.

7. Unnecessary errors

It is all the results from the manufacturing process that cause a state of poor quality in the product and operations, including an error in the product itself, which directly causes a high cost, an error in documents related to the production that leads to giving wrong information to various work centers, a delay in production or marketing, which leads to a delay production cycle.

It was mentioned by (Gulshan & Sing, 2012:58) that the goal of lean manufacturing is to increase the added value of work by eliminating the seven basic types of waste, which are: (excessive production - excessive movement - waiting for the worker, machine, materials - process - storage - Wastage due to correction-transportation).

3.2 Literature

3.2.1 Arabic Literature

Mahdi's study entitled: "Dimensions Analysis of Lean Manufacturing using the Hierarchical Analysis Process (AHP): An Applied Study in Zain Soft Drinks Company" aimed to analyze and measure the reality of the dimensions of lean manufacturing in Zain Soft Drinks Company and determine the dimensions that require greater attention In an attempt to test the reality of Lean manufacturing in the Iraqi manufacturing environment, the applied approach was used to reach the objectives of the research, and the hierarchical analysis process was utilized to measure the dimensions of Lean manufacturing.

A study by (Jaba, 2017) entitled: "The Role of Lean Manufacturing in Eliminating Waste in the Production Institution" aimed to shed light on the most important modern method of production management, which is the Lean Manufacturing method, and reviews the various forms of waste that the organization may face during the production process, the researcher relied on the descriptive approach, and the effective role that Lean Manufacturing plays in eliminating waste and waste in the organization was demonstrated through a set of mechanisms and tools.

A study by (Al-Azab, 2016) entitled: "The Impact of the Application of Lean Manufacturing System on Profitability: An Applied Study on the Jordanian Public Shareholding Industrial Companies" aimed to determine the impact of the application of the Lean Manufacturing System in its various dimensions, processes, and equipment, planning, and control, human resources, the relationship with the supplier, the relationship with the customer) on profitability in its dimensions (return on assets, return on equity) in Jordanian industrial companies, and the study found a statistically significant effect at the level of significance ($\alpha \leq 0.05$) between the lean manufacturing system as a whole and profitability In terms of its measures as a whole, it was also found that there is a statistically significant relationship between the Lean manufacturing system dimensions and the profitability indicators.

A study by (Al-Asbah, 2021) entitled: "The Impact of Lean Manufacturing on Competitive Strategies in Aluminum Manufacturing Companies" aimed to identify the impact of Lean Manufacturing on the competitive strategies of aluminum manufacturing companies in Jordan, where a questionnaire was distributed to department managers and employees, sales staff and production engineers in (12) out of (17) companies specialized in the aluminum industry for the purpose of achieving the objective of the study. The study concluded that there is a relationship between the elements of Lean Manufacturing and Competitive Strategies, and it was found that there is an impact of Lean Manufacturing on Competitive Strategies in general.

3.2.2 Foreign Studies

A study by (Chauhan & Singh, 2012) entitled: "Measuring parameters of lean manufacturing realization" aimed to measure the parameters of lean manufacturing in Indian companies and to reveal areas that require immediate attention to achieve the principles of lean manufacturing, and the questionnaire was used as a tool for research; the study concluded that lean manufacturing is not very good in Indian industry, and there are many areas for improving the business of Indian industrial companies.

A study of (Agus et al, 2012) entitled: "Lean production supply chain management as driver towards enhancing product quality and business performance" aimed to identify the relationship between the lean manufacturing process and product quality in the performance of business organizations as a means to improve the industrial competitive advantage in Malaysia, and also aimed at obtaining a better understanding about the extent of the penetration of Lean production in Malaysian manufacturing companies by relying on the perception of supply chain management managers or production managers, and the questionnaire was used as a tool for the study, and the study sample were production managers who adopt the idea of Lean manufacturing within the supply chains of those successful factories within the Malaysian Lean Production Index, One of the results of this study was that the requirements of Lean manufacturing represented in reducing preparation time, continuous improvement of operations, use of withdrawal system, and the study found that reducing preparation time has great importance in linking Lean production and product quality performance and business performance.

A study by (Mady, 2020) entitled: "Lean Manufacturing Dimensions and Its Relationship in Promoting The Improvement of Production Processes in Industrial Companies" aimed to determine the extent of the impact of the lean manufacturing strategy on improving the production process, and the descriptive approach was used as an approach to the study, and the study concluded that there is a positive correlation between the dimensions of the lean manufacturing process and productivity improvement, and the researcher suggested to adopt the good application of lean manufacturing and work to ensure the success of this application.

4. The Practical Framework

4.1 Introduction

Lean manufacturing can be achieved throughout many dimensions in the General Automobile Company in Alexandria and which are: (elimination of waste, continuous improvement, zero defects, on-time delivery, raw material withdrawal, multi-functional teams, decentralization, job integration, information systems vertical) and through the hierarchical analysis process (AHP) it is possible to form a matrix of binary comparisons according to the preference scale of the decision-maker in the General Automobile Company in Alexandria.

4.2 Preference Scale

The Preference Scale contributes to the formation of the matrix of binary comparisons through the Hierarchical Analysis Process (AHP) by comparing each of the two criteria and estimating a numerical value.

Table No. (1) Preference Scale

Preference level	Numerical rates
Absolutely favorable	9
strongly favorable	7
very favorable	5
medium preference	3
equal preference	1
Intermediate preference between values	2/4/6/8

4.3 The development of matrices of binary comparisons

The development of the numerical value depends on the preference of the decision-maker in the General Automobile Company in Alexandria to make judgments and prepare a matrix of binary comparisons, as shown in the following table:

Table No. (2) The matrix of binary comparisons for the dimensions of lean manufacturing in the General Automobile Company in Alexandria

Dimensions	Waste elimination	Continuous improvement	Zero defects	On-time delivery	Raw material withdrawal	Multi-functional teams	Decentralization	Job integration	Vertical information systems
Waste Elimination	1	1	2	1	1	3	3	3	3
Continuous improvement	1	1	2	0.500	0.500	3	3	2	2
Zero defects	0.500	0.500	1	0.333	0.500	3	2	2	2
On-time delivery	1	2	3	1	1	2	3	2	2
Raw material withdrawal	1	2	2	1	1	2	2	2	3
Multi-functional teams	0.333	0.3333	0.333	0.500	0.500	1	1	1	1
Decentralization	0.333	0.333	0.5	0.333	0.5	1	1	1	1
job integration	0.333	0.500	0.500	0.500	0.500	1	1	1	1
Vertical information systems	0.333	0.500	0.500	0.500	0.333	1	1	1	1
Total	**5.832**	**8.166**	**11.833**	**5.666**	**5.833**	**17**	**17**	**15**	**16**

Based on the above table, the estimates of binary comparisons show that each dimension in the first column is compared with a dimension in the first row, and so on, so we can conclude the followings:

After eliminating waste preference level is equal to (1) with dimensions (continuous improvement, on-time delivery, recall of raw materials), and equal to medium (2) with dimension (zero defects) and medium preference (3) with dimensions (multifunctional difference, decentralization, functional integration, vertical information systems) and that the continuous improvement dimension is equally preferred to medium (2) with dimensions (zero defects, job integration, vertical information systems) and equally unfavorable to medium (0.500) with two dimensions (on-time delivery, raw material withdrawal) and moderately preferred (3) With Dimensional (Multifunctional Teams, Decentralized).

It is clear that the zero defects dimension is moderately unfavorable (0.333) with the on-time delivery dimension and equally unfavorable to medium (0.500) with the raw material withdrawal dimension, moderately preferred (3) with a multi-functional difference dimension, and equally preferred to medium (2) with dimensions (decentralization, functional integration, vertical information systems).

It is clear also that the on-time delivery dimension is equal in preference (1) with the dimension of raw materials withdrawal and is equally preferred to average (2) with dimensions (multifunctional teams, job integration, vertical information systems) and moderately preferred (3) with the decentralization dimension.

It is clear that the dimension of raw materials withdrawal is equally preferred to average (2) with the dimensions (multifunctional teams, decentralization, integration of functions) and moderately preferred (3) with the vertical information systems dimension.

It was also found that the multi-functional teams' dimension is equal in preference (1) with the dimensions (decentralization, job integration, vertical information systems).

It is clear that the decentralization dimension is equal in preference (1) with two dimensions (functional integration and vertical information systems).

Also, the job integration dimension is equal in preference (1) to the vertical information systems dimension, and the lower part of the matrix is the inverse of the binary comparison of the upper part of the matrix.

4.4 Prepare the natural matrix

The normal matrix will be prepared by calculating the sum of each column of the binary comparison matrix and then dividing the value of each cell of the column by the sum of the values of that column, as shown in Table (3)

4.5 Consistency and stability

The hierarchical analysis process provides a measure of the consistency of the values of binary comparisons, which contributes to increasing the decision-maker's ability to determine the importance of each dimension compared to the other. If the consistency value is equal to or less than (0.01), it is acceptable and expresses the level of consistency between the binary comparisons; either if it is greater than (0.01), it needs to modify the original values in the binary comparison array.

The matrix symmetry is calculated as follows:

1. Calculate the mean of each row in the natural matrix to get the preference vector.
2. Multiply each row of the binary comparison by the preference vector to get a matrix (AW) (A matrix / W represents a given weight).
3. Divide each value of the AW matrix by the corresponding elements of the preference vector to get the eigenvalues.
4. Calculating the mean of the self-values (10.21).
5. Calculation of the consistency index (average eigenvalues / number of dimensions -1) and it is equal to 0.1515.
6. Calculating the stability ratio (consistency index / random index) and it is equal to (0.104).
7. And the value of the random index is (1.45) as it depends on the number of criteria and dimensions (n = 9).

The preference vector shows the relative weights of the dimensions of lean manufacturing in the General Automobile Company in Alexandria, where it was found that after delivery at a specific time is the largest dimension in terms of relative weight with a value of 0.175, then after eliminating waste with a value of 0.174, followed by the dimension of vertical information systems, then after the withdrawal of raw materials, then after Continuous improvement, then after zero defects, then after integration of functions, then after a multi-functional difference with a value of (0.168, 0.166, 0.139, 0.103, 0.065, 0.061), respectively, and finally after decentralization with a value of 0.059 as shown in Table (3)

Table No. (3) Normal matrix

Dimensions	Waste elimination	Continuous improvement	Zero defects	On-time delivery	Raw material withdrawal	Multi-functional teams	Decentralization	Job integration	Vertical information systems	Preference vector
Waste Elimination	0.171	0.122	0.169	0.176	0.171	0.176	0.176	0.200	0.188	0.174
Continuous improvement	0.171	0.122	0.169	0.088	0.086	0.176	0.176	0.133	0.125	0.139
Zero defects	0.086	0.061	0.085	0.059	0.086	0.176	0.118	0.133	0.125	0.103
On-time delivery	0.171	0.245	0.254	0.176	0.171	0.118	0.176	0.133	0.125	0.175
Raw material withdrawal	0.171	0.245	0.169	0.176	0.171	0.118	0.118	0.133	0.188	0.166
Multi-functional teams	0.057	0.041	0.028	0.088	0.086	0.059	0.059	0.067	0.063	0.061
Decentralization	0.057	0.041	0.042	0.059	0.086	0.059	0.059	0.067	0.063	0.059
job integration	0.057	0.061	0.042	0.088	0.086	0.059	0.059	0.067	0.063	0.065
Vertical information systems	0.057	0.061	0.042	0.088	0.057	0.059	0.059	0.067	0.063	0.168
Total										1.108

4.6 Calculating the final weights for dimensions and standards

The values of each dimension of Lean Manufacturing are calculated at the General Automobile Company in Alexandria through:

1. The value of the dimension = (the actual total points of the dimension) / number of questions x the highest point of the question (n * 5).
2. Total Lean Manufacturing Value = Dimension Value * Relative Dimension Weight.
3. The value of the dimensions of Lean Manufacturing in the General Automobile Company in Alexandria:
   Elimination of waste = 0.679 * 0.174 = 0.118
   Continuous improvement = 0.639 * 0.139 = 0.089
   Zero defects = 0.669 * 0.103 = 0.069
   Delivery time = 0.687 * 0.175 = 0.120
   Raw material withdrawal = 0.677 * 0.166 = 0.112
   Multifunction difference = 0.665 * 0.061 = 0.041
   Decentralization = 0.509 * 0.059 = 0.030
   Function integration = 0.707 * 0.065 = 0.046
   Vertical Information Systems = 0.059 * 0.168 = 0.010

The total value of Lean Manufacturing in the General Automobile Company in Alexandria = 0.635, and this value is considered Medium.

5. Findings and Recommendations

5.1 The Findings of the study

1. Despite the effectiveness of the hierarchical analysis process, it is criticized as it depends on the opinions and ideas of the people involved in issuing decisions only, without taking into consideration the opinion of other workers in the company.
2. There is a medium value for Lean Manufacturing in the General Automobile Company in Alexandria; results show that the company has a medium amount of capabilities needed by Lean Manufacturing and that it needs to provide greater capabilities in order to gain the advantages of Lean manufacturing.

3. The results of the study showed that there is an interest from the management of the General Automobile Company in Alexandria in achieving lean manufacturing, but this interest requires work to provide a lot of capabilities that are required to achieve lean manufacturing.

5.2 Recommendations

1. The necessity of paying attention to the dimensions of low relative weight and working on increasing the level of their quality and efficiency, which contributes to increasing their relative weight and achieving the lean manufacturing process effectively.
2. Paying attention to the dimensions with a high relative weight and maintaining this level to benefit from them in implementing the lean manufacturing process at the General Automobile Company in Alexandria.
3. Work to raise the level of awareness of workers in the General Automobile Company in Alexandria of the importance of applying the lean manufacturing process and the advantages that accrue to the company from its implementation.
4. Raising the level of awareness of workers in the General Automobile Company in Alexandria of the importance of increasing the level of efficiency of the dimensions of lean manufacturing, eliminating waste, and improving productivity.
5. Working on providing all the capabilities required by the lean manufacturing process at the Automobile Company in Alexandria.

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