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The Role of Lean Production and Other Technologies in Reducing Production Costs

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The techniques lean production, robot and total quality management are important to reduce production costs and improve the quality of products which then meet the needs and desire of customers, leading to higher sales volume and achieving high levels of profits. The statistical analysis shows the proportion of influence and power between those independent variables (lean production, robot, total quality management) and the dependent variable (reduce of product costs) as follows:

1-The total of regression coefficient of the independent variables (lean production, robot, total quality management) is (0.573). This reflects the strength of the influence of these variables on the dependent variable (reducing the product costs). As the relationship is direct between them, the higher the regression coefficient, leading to a stronger influence of the independent variables on the dependent variable.

2- The coefficient of determination for independent variables (lean production, robot, total quality management) and the dependent variable (reducing the product costs) is the coefficient (0.526), where the percentage of influence of the independent variables is (52.6%) and is a good ratio. As for the complement of ratio, it is (47.4%) back to other factors not covered by this article.

3- Based on the statistical analysis in table 10, with respect to a regression coefficient (R2), the coefficient of determination (B) and the natural significant relationship, the researcher confirms the importance of the adoption of Iraqi manufacturing, including the service industry, So the use of modern production techniques contributes to improving the competitive position of the Iraqi industry.

4- The researcher indicates that competition in the price led many international companies (Japanese and American) to transfer some of their factories to countries with low operating costs, such as China, even though these companies are technologically advanced and use the

best modern production technologies such as lean production, robots, and total quality management. Those who visit the USA will find that the goods produced in China have invaded the markets there due to price competition and the relatively low cost of production in China, as well as the current trend towards at the service industry in USA.

Key word: *Lean Production, Robot, Total Quality Management, Reduce Product Costs.*

1. Introduction:

Profit-oriented entity units face many serious challenges, including high production costs and price competition. Therefore, entity units strive to maintain their market share by controlling these two variables and using modern production technology that allows the entity unit to compete in the current work environment.

The use of modern production techniques, such as lean production, robot and total quality management, gives the entity unit the opportunity to compete and create a competitive advantage by reducing the cost of the product and increasing its quality. At a time when lean production technology reduces the costs of investment in inventory in all kinds and benefits from the characteristics of Just In Time technology, " Just in Time It is a system that aims to make the cost of inventory of all types of finished goods, work in process, raw materials equal to zero". the entity unit increases its investments in modern technology where machinery and equipment with high automation and accuracy and quality in work so that it meets to a high degree the desires and needs of customers and also what we see today from the use of many world companies as a Toyota company, has robot technology on a large scale in automobile production factories, which provides a high degree of control and quality and facilitates the ability to change the design to suit the tastes of customers and global market trends, as well as the programs of total quality management that seek to reduce the costs of recycling defective production and costs of damage and scrap to the lowest levels, and certainly the entity unit when it is at this level of development in the use of technology, it will be a pioneer in its field of activity, and this is exactly what is happening. This is exactly what happens to many Japanese and American companies and others, which are looking at the forefront of international companies.

2. Research problem:

Local and international companies face a major problem, represented by the high costs of the product. Many entity units have left the job market because of high competition with foreign products, as is the case in Iraq and many countries. Therefore, many international companies

have sought, in order to reduce production costs, to transfer their factories to countries with low operational cost, like China, despite possessing advanced technology and its products being of high quality because of its high experience and huge investments. Sometimes many countries face additional complications for developing the industrial infrastructure, such as lack of investment or political problems and security in the country, in addition to the transfer of technology problems, and these factors lead to an additional increase in production costs.

3. Research objective:

The research aims to examine modern technologies in production and highlight the characteristics of each and its role in reducing the cost of the product. In this way each technique focuses on reducing the cost of the product from a certain angle. Lean production reduces the cost of a product by reducing the investment at inventory to the lowest level, while robot technology reduces the product costs through reducing the variable costs of the product. Finally, total quality management reduces the costs of the product by focusing on recycling defective products and reducing the costs of damage and scrap.

4. Research hypothesis:

The use of modern technologies in production such as lean production, robot and total quality management leads to a reduction in the cost of the product, an improvement in its quality, and the creation of a competitive advantage for an entity unit.

5. Research importance:

The importance of the research comes from the fact that the cost and quality of the product directly affects the customer's satisfaction and there are several factors that influence and reduce the cost of the product, including modern techniques used in production such as lean production technology, robot technology and total quality management.

6. Research method:

The researcher did not find actual information related to the use of modern techniques of production in the entity units in Baghdad, Iraq, because of the obsolescence of the technologies used in the factories compared to the modern technology used in this research. Therefore, the researcher prepared a questionnaire to cover the research.

7. Theoretical Framework for modern production techniques.

7.1. Lean production.

7.1.1. Lean production concept.

The concept of lean production means studying and analysing the entire course of production processes starting from the stage of ordering, research and development, design, production and delivery to customers, targeting any activity that does not add value to the customer. Thereby lean production is eliminating waste of all kinds. The nature of lean production was not limited to manufacturing processes, but rather extended to all activates such as service, commercial and scientific. The lean production system was developed by Toyota Company in order to obtain the best quality, the lowest cost and the shortest time to meet the needs of customers by eliminating any waste. The lean production technique was based on two concepts: (www.lean production / Toyota, 2011).

- High Automation (JIDOKA): This means when a problem occurs, the equipment stops immediately and then the malfunction is automatically fixed.

- JIT: means that every industrial process produces what is required by the subsequent process for it.

7.1.2. Waste concept according to lean production.

Waste in the Japanese language (Muda) means anything more than the minimum, whether this thing is equipment, raw materials, parts, spaces or worker time, and these things are very necessary to add value to the product. There are several types of wastage as follows:

First: the overproduction, which occurs as a result of producing more than customers demand.
Second: waiting is a delay that occurs between industrial processes or production stages, the wait resulting from the completion of a process and the commencement of a subsequent process.
Third: over-processing is caused by adding more value to the product or service than the customer needs.
Fourth: inventory occurs when the company has more primary material or more information than it needs today.
Fifth: motion, which occurs when workers are needlessly moved from one place to another.
Sixth: Unnecessary industrial processes.

Seventh: Production defects, any feature added to the product that does not correspond to the customer's use.

Waste may be represented by many practices such as monitoring the work of machines, waiting for completed parts, inspecting parts, checking equipment, malfunctioning machines, recycling damage) (www.lean production / Toyota, 2011)

7.1.3. Basics principles for lean production:

A- Determine the value of the product or service, the value is determined only by the consumer or the customer and is in the form of a product or service that meets the needs of the customer at an acceptable price and during a specific period.
B- Defining and creating value streams, by identifying the manufacturing processes that achieve value, so that the value streams start from the supply of raw materials to the final product that reaches to the customer.
C- Making value flow procedures or organising work arrangements around the flow of production processes, and the volume of production will continue to cover the requirement of customer needs while avoiding the accumulation of inventory at any production stage.
D- Depend on pull production system instead of push, the manufacturing relies on the requirement and needs of the customer.
E- The pursuit of perfection or continuing to follow manufacturing processes. Perfection does not only mean quality, but rather it means that production fully meets what the customer wants with the time needed and at an acceptable price with a minimum of damage or waste . (Www. T E., 2010).

7.1.4. Goals lean production.

Lean production has a group of main objectives, as follows:

A - Inventory reduction of all kinds.
B - Waste reduction or elimination.
C - Reduce wasted efforts
D - Responding to customer requests within the shortest possible period.
E - Improving the processes that achieve the link between companies, such as the supply chain, as business operations are coordinated to obtain the best service for consumers.

Thus, lean production aims to have a waste ratio equal to zero in all areas, such as malfunctions or stops in the machines, the time of preparation of the machines, the number of units of the

defective product, the period of supply, the speed of response to customer requests, the increase of production capacity, improving quality, increasing profitability, competitiveness, and also reduce product costs. (www.scribd.com)

7.1.5. Lean production steps

First: Determine the value of the product or service.
Second: Determine the processes that lead to obtaining the value.
Third: Arranging manufacturing processes related to the flow of productive processes.
Fourth: Creating pull system that responds to customer requests.
Fifth: Continue to follow up the completion of manufacturing processes.
(Garrison & Noreen & Brewer, 2012, p. 11)

7.1.6. Expected result from lean production.

- Significant reduction or removal of all types of inventory.
- Reducing production time by more than 50 percent.
- Simplifying manufacturing processes.
- Improving quality and reducing the time spent on quality tests.
- Improving morale by seeing production processes go according to the philosophy of lean production.
- Increase production capacity.
- Workers with multiple skills.
- Achieving high profitability.
- Increasing market share (www.leanresult.au)

7.1.7. The lean production system and its effect on reducing the costs of the product.

The lean production system relies on the concepts of high automation and the philosophy of Just In Time, which makes it benefit from the characteristics of Just In Time philosophy . These benefits include that the lean production has a great impact on reducing investments in inventory that Just in Time goals make manufacturing processes flexible and the flow of raw materials is in a high flow, and the system of JIT " JIT means Just in Time system" has an impact on product costs. The question is what happens when the manufacturing overhead costs are charged too much or too little when using the JIT system? The balance of inventory in work process and inventory of finished goods were usually very small when compared to the balance of the cost of the sold goods. Thus, the difference between allocating less than or more than from manufacturing overhead costs to the cost of the sold goods, or allocating them between the

inventory in work process and the inventory of finished goods and costs of goods sold, is probably very small. Simply, allocating overhead costs on cost of goods sold is appropriate and suitable. The adoption of JIT leads to adding value to shareholders by reducing investments in inventory and eliminating costs related to activities that do not add value to the product and the customer. On this basis, Japanese companies, led by Toyota Motors, adopted an innovative manufacturing system called Lean Production. This system aims to make inventory of raw materials, inventory of work in process and inventory of finished goods production at its lowest levels or equal to zero. Companies that rely on this system are organizing the contracts with suppliers to supply it with raw materials and other parts so that they reach production processes when they are needed. Also, when the company has several production lines, then manufacturing processes are scheduled so that the products of a production line are inputs to another production line. The lean production system also avoids the accumulation of inventory of all kinds so that it does not occupy any of the company's spaces, there are no lubricant oils inside the factory or lost areas and there are no excess investments in the inventory. (Jiambalvo, 2010, p. 59)

The American company Hewlett- Packard adopted JIT system two years ago and the results were that the inventory of work in process decreased by 82 percent and the costs of scrap and recycling decreased by 50 percent. The JIT system not only reduces the cost of the inventory but also leads to better and faster production and the waste rate is less. There are also benefits in the field of accounting and cost tracking under JIT, as the inventory of raw materials account and the work in process account are combined within a single account.

7.2. Robots.

Computer control on manufacturing process may be called Computer - Controlled manufacturing. Many manufacturing companies use high automation in their manufacturing operations, or what is called computerised manufacturing systems. Computers are used to control equipment, including robots, and in general, this leads to flexibility and accuracy in production processes, and the use of these advanced technologies in manufacturing processes will have a significant impact on the composition of product costs.

Studies indicate that on average, product costs in recent years for companies consist of 53 percent of the cost of raw materials, 15 percent of the cost of direct labour, 32 percent of manufacturing overhead costs. They also found that some companies with high automation such as Hewlett Packard for computers, product costs consist of a small percentage of labour costs and this constitutes 3 percent of the total production costs, and the decrease in direct labour costs drives companies to reconsider relying on direct labour as an appropriate basis for allocating manufacturing overhead costs to production. Currently, most companies use hours of work and

direct labour costs. In any case, for companies with high automation when using direct labour costs as a basis for allocating manufacturing overhead costs, this is an inappropriate basis; the cost structure in companies with high automation will change and in general the high automation leads to an increase in fixed costs and a decrease in variable costs, and this is reflected positively in reducing the costs of the product. (Jiambalvo, 2010, p. 60)

7.3.Total Quality Management.

In light of the global competitive environment, companies realise the importance of producing high quality products. Most companies have adopted total quality management programs to ensure that their products are of high quality and their manufacturing processes are highly efficient. Most companies have developed total quality management programs in a way that meets the needs of customers by providing products in a timely manner, with a tremendous reduction in defective products that are recycled, and workers being encouraged to continuously improve manufacturing processes. In fact, total quality management programs mean continuous quality improvement, and also access to critical success factors, and the results of total quality management are really impressive. One of the factories that produce electronic devices in Washington State and has statistics about the total quality management program found that total quality reduces the cost of recycling in some production lines of electronic devices by 66 percent, it reduces the cost of scrap by 60 percent and also the product life cycle decreased by 90 percent .

It is worth mentioning that significantly reducing the levels of recycling costs of defective production and costs of scrap will reduce the costs of tracking these costs in the company's accounting system. In all cases, the total quality reduces the costs of the product, which leads to achieving customer satisfaction and then obtaining a competitive advantage that enables the company to achieve more sales and then to achieve greater profit (Al - Janabi, 2009, p. 7).

The Total Quality Technology integrates with the Lean Production Technology, as the Total Quality Technology aims to reach the product quality and the quality of the company as a whole and then to reach the zero defect and reduce or cancel the damage and its cost in order to reduce the total production costs in a manner that achieves competitive advantage and customer satisfaction. Thus, total quality aims to achieve the requirements of customers and gain their satisfaction and loyalty through quality control that the content of total quality focuses on the following: (Saied, Abdel-Fattah, 2010, p.7)

- Responding to the desires and needs of customers.
- Improve product quality.

- Reducing product costs without compromising product quality.
- Maintaining market share and competitive advantage.

(Mahdi, Al-Mousasi, 2010, p. 13)

7.4.The practical side of the research.

Data collection methods:

To achieve the main objective of this research, a sample consisting of 25 people was taken from three companies, as follows:

1- Baghdad company for the manufacture of packaging materials, holding the international number ISIN IQ 000A0M7TW0 and having capital of 10.8 million dinars, from which (8) people have been chosen.
2- Baghdad Soft Drinks Company, international number ISIN IQ000A0M7TT6, capital is 177.3 Billion dinars and (8) people have been chosen.
3- Iraqi Carton Industry Company, international number ISIN is IQ000A0M7T17, capital is 75.9 Billion dinars and (9) people have been chosen.

To achieve the main objective of this research, a questionnaire was designed consisting of two parts, the first consisting of three independent variables represented by (Lean Production, Robot, TQM) and the number of questions of this part reached (18) questions, while the second part of the questionnaire is the Reduce Product costs consisting of seven questions, and the Five Point liker Scale was used.

7.5.Second: Description of general information for the research sample.

Table No. (1)
The table shows a description of the sample in terms of certificate and scientific title.

Details	Diploma	Bachelor	High Diploma	Master	Total
Design Engineer	--	1	1	1	3
Managerial Accountant	1	3	1	--	5
Account Manager	2	3	1	1	7

Production Manager	--	2	1	1	4
Factory Manager	--	1	2	3	6
Total	3	10	6	6	25

Table (1) shows that the research sample relied on three industrial companies registered in the Iraq Stock Exchange. A number of workers in these companies were chosen as a random sample at the rate of 8, 8, 9 influential people from each company and the questionnaire was provided to them. The sample are influential people making decisions in their companies. Table (1) also shows the academic level of the individuals in the research sample.

7.6. Third: Validity and reliability test of the research questionnaire.

7.6.1. Content validity test.

This means the ability of the questionnaire to express the goal that was designed for the sake of it. There are several statistical methods for measuring the validity of the questionnaire, and the most important, most common and accurate is the method of the Comparison of Extreme Groups. This idea of this method is summarised by arranging the results of questionnaire in ascending order, and divided into two groups, then a choice 27 percent of the highest scores as a first group and 27 percent of the lowest scores as a second group, and the test (t) is calculated according to the following formula:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

$\bar{x}_2, \bar{x}_1$ They are the average of the first group and the average of the second group, respectively.

S_2^2, S_1^2 They are the variance of the first group and the variance of the second group, respectively.

Then we compare the calculated value of t (7.25) with the tabular value (1.645) at the significance level of 0.05 and the degree of freedom (1.28), where the calculated value is greater than the tabular value so there are differences between the two averages and the questionnaire is true in its measurement and vice versa.

7.6.2. Test questionnaire stability.

Stability means that the scale of the questionnaire gives the same results to the dates of its application to the same study population after a period of time. There are several statistical methods to show the extent of the stability of the questionnaire scale, all of which depend on the idea of the correlation coefficient. Among the most important and most common formulas is the Guttmann formula:

$$R = 2(1 - \frac{S_1^2 + S_2^2}{S^2})$$

R Coefficient of stability

S_2^2 Varying the degrees of doubles questions

S^2 Variation in the degrees of all questions

Table No. (2)
The table shows the results of validity and coefficient of stability

Questionnaire axes	t- calculated	Coefficient of stability (R)
Lean production	8.12	0.59
Robots	6.21	0.81
TQM	3.16	0.59
Reduce the product costs	4.15	0.66
Total	7.25	0.76

Table (2) shows the tabular value (t) of the truth test (1.645) and that the calculated value (t) was greater than the tabular and this confirms the validity of the questionnaire scale. The stability factor is more than 0.5, which confirms the stability of the questionnaire scale for the variables under researched.

7.6.3. Test the difference in the opinions of the research sample when answering the questionnaire questions.

Table (3)

Shows the difference in opinions of the research sample when answering the questionnaire questions

Questionnaire axes	Mean	Standard deviation	Coefficient of variation
Lean production	4.388	0.70301	16.021
Robot	4.257	0.78107	18.347
TQM	4.373	0.69538	15.900
Reduce of product costs	4.2857	0.69211	16.149

Table (3) shows the degree of difference in the views of the research sample with respect to each axis of the questionnaire. The coefficient of variation for the research sample for axes of (lean production, robots, and total quality management) are (50.268), while the coefficient of variation for the axis of reduce product costs (16.149). The differences in the opinions for the research sample at the axes of the questionnaire indicates the difference in the scientific and practical backgrounds of the members of the research sample and its effect on their opinions.

$$C.V = \frac{S}{X} * 100$$

Whereas:

C.V: Coefficient of variation S: Standard deviation X: Mean

7.7. Analyse the answers of the research sample.

7.7.1. Weight Mean, Percent Weight, Standard Deviation

Table (4)
Weight mean, percent weight, and standard deviation of the Lean Production axis

Sequence	Details	Weight mean	Percent weight	Standard deviation
1	In lean production, accumulated production that is more than the customer demands is avoided.	4.48	90%	0.71414
2	Lean production provides an opportunity to avoid the wait period resulting from the end of a process and start of a subsequent manufacturing process.	4.48	90%	0.50990
3	Lean production contributes to a significant reduction in all kinds of inventory (raw materials, work in process , finished goods) until it practically reaches the zero inventory.	4.404	88%	0.70711
4	Lean production reduces the time spent on quality tests.	4.32	86%	0.743833
5	Lean production increases production capacity and increases profitability.	4.12	82%	0.78102
6	Lean production leads to raising the morale of workers as a result of seeing manufacturing processes go according to the technique of lean production.	4.44	89%	0.71181

Table (4) shows the analysis of the answers of the research sample to the axis of lean production techniques, where the weight mean of the lean production ranges between 4.48 for the first question (In lean production, accumulated production that is more than the customer demands is avoided), and 4.12 for the fifth question (Lean production increases production capacity and increases profitability). As the analysis shows, the agreement of the opinions of the research sample with what the researcher proposed to determine the characteristics of lean production and its effect on reducing the costs of the product, as that percent weight ranges between (90% - 82%).

Table (5)
Weight mean, percent weight, and standard deviation of the Robot axis

Sequence	Details	Weight mean	Percent weight	Standard deviation
1	Many manufacturing companies use automation on a large scale, meaning that computers and robots control various manufacturing equipment and processes.	4.36	87%	0.70000
2	The use of robots leads to increased flexibility and accuracy in production processes.	4.00	80%	0.81650
3	The highly automated equipment helps companies meet the challenges of high global competition.	4.28	86%	0.79162
4	Some studies indicate that product costs in recent years consist of 35% of materials, 15% of direct wages, and 50% manufacturing overhead costs, and this depends on the nature of the manufacturing.	4.08	82%	0.90921
5	Some companies with high automation, such as HP for computers, the direct labour cost is about 3% of the total production cost, and the reduction in the direct labour cost has made many companies rely on manufacturing overhead costs as a basis for allocation instead of the direct labour cost, which is no longer appropriate.	4.24	85%	0.77889
6	The use of robots in high-risk manufacturing such as iron and steel, shipbuilding and others has reduced insurance costs for workers, which has been reflected in reducing the product costs	4.36	87%	0.75719

Table (5) shows the analysis of the answers of the research sample to the Robot axis, as this analysis shows the agreement of the opinions of the research sample with what the researcher suggested in determining the Robot axis in order to positively affect the axis of reducing the cost of the product, and the weight mean for this axis ranged between (4.36) for the first question (Many manufacturing companies use automation on a large scale, meaning that computers and robots control various manufacturing equipment and processes) and (4.00) for the second question (The use of robots leads to increased flexibility and accuracy in production processes).

Table (6)
Weight means, percent weight and standard deviation of the Total Quality Management axis

Sequence	Details	Weight mean	Percent weight	Standard deviation
1	As a result of the highly competitive environment between companies, it understands the importance of producing high quality products that are suitable for customers' use.	4.52	90%	0.6532 0
2	An increasing number of companies have total quality management institutes and programs to ensure that their products are of high quality and that their manufacturing processes are efficient.	4.44	89%	0.65064
3	Most companies that adopt total quality management develop their philosophy to focus on what the customer needs and reduce defective production and encourage workers to continuously improve production processes	4.52	90%	0.71414
4	In light of high competition, companies cannot survive without depending on total quality management	20 4.	84%	0.76376
5	The total quality management affects the cost of the product by reducing the cost of scrap and the cost of recycling, that is, it reduces the percentage of defective production and damage to the lowest possible	4.4 4	89%	0.71181
6	Total quality reduces the cost of the product and also contributes to customer satisfaction.	4.32	86%	0.690

Table (6) shows the analysis of the answers of the research sample to the total quality management axis, as this analysis shows the agreement of the opinions of the research sample with what the researcher proposed. In determining the total quality management in order to positively affect the cost of the product and the weight mean for this axis, results ranged between (4.52) for the third question (Most companies that adopt total quality management develop their philosophy to focus on what the customer needs and reduce defective production and encourage workers to continuously improve production processes) and (4.20) for the fourth question (In light of high competition, companies cannot survive without depend on total quality management).

Table (7)

Weight mean, percent weight, and standard deviation of the Reducing the product costs axis

Sequence	Details	Weight mean	Percent weight	Standard deviation
1	Many companies adopting lean production leads to a 90% reduction in production time (waiting time for production), a reduction in the areas required for production of 80% and a reduction in the work in process cost of 32%	4.24	85%	0.72342
2	Companies that adopt Lean Production technology generally add value to shareholders by reducing investments in inventory and also by removing costs associated with activities that do not add value	4.32	86%	0.62716
3	Companies that rely on lean production reduce the cost of their products and reduce the product life cycle	4.40	88%	0.70711
4	The automation and robot that have a significant impact on the composition and cost reduction of the product	4.24	85%	0.72342
5	Increasing companies 'investment in modern high automation equipment affects the cost structure, leads to increased fixed costs, reduces variable costs, and leads to reduced product costs	4.32	86%	0.62716
6	Usually high automation leads to increasing the manufacturing overhead costs and fixed costs and reduces the cost of labour.	4.32	86%	0.69041
7	The results of one of the studies indicates that efficient programs of total quality management can be impressive, as there are programs that reduce waste recycling operations by 60%, reduce the cost of scrap from manufacturing processes by 60% and also reduce the time required for production from the beginning to the end by 90%	4.16	83%	0.74610

Table (7) shows the analysis of the answers of the research sample to the axis of reducing the cost of the product. The analysis shows the agreement of the opinions of the research sample with what the researcher proposed in determining the axis of reducing the costs of the product and the extent of its influence on independent variables such as lean production, robot, and total quality management. The weight mean of this axis ranged between (4.40) for the third question (Companies that rely on lean production reduce the cost of their products and reduce the product life cycle) and (4.16) for the seventh question (The results of one of the studies indicate that efficient programs of total quality management can be impressive, as there are programs that reduce waste recycling operations by 60%, reduce the cost of scrap from manufacturing processes by 60% and also reduce the time required for production from the beginning to the end by 90%).

7.7.2. Factor Analysis.

This analysis is used to study the answers of the research sample for each axis of the questionnaire. It then divides the answers into groups according to the values of those groups so that each group consists of a number of variables (questionnaire items) and at the same time shows the nature of the correlation of each variable with its group. The relationship may be a negative or positive effect, and to show the effect of this analysis on the arrangement of variables according to its importance from the point of view of the answers of the research sample, we take the Lean Production axis as a model for this analysis from the viewpoint of the research sample.

Table (8)

The sequence of groups is shown according to their value and the cumulative proportions of the variance of each.

Sequence group	Total value for each group	The ratio of variance of the first group to the grand total	Cumulative percentages of the group contrast ratio
1	4.329	21.645	21.645
2	3.877	19.385	41.029
3	1.896	9.479	50.508
4	1.571	7.853	58.361
5	1.528	7.641	66.002
6	1.282	6.410	72.412
7	1.087	5.435	77.847

Table (8) shows this analysis showed us the answers of the research sample for the lean production axis, as it consists of seven groups whose total value ranged between 4.329 for the first group and 1.087 for the seventh group, and with cumulative percentages ranging between 21.645% for the first group and 77.847% for the seventh group and a variance ratio of 21.645 for the first group and 5.435 for the seventh group.

Table (9)

The degree of saturation of the variables (questions) that most affect the Lean Production axis from the point of view of the research sample and not as arranged in the questionnaire.

Sequence according to importance	The first group variables from the lean production axis	Amount of saturation
3	Lean production contributes to a significant reduction the all kinds of inventory (raw materials, work in process, finished goods) until it practically reaches the zero inventory.	0.672
6	Lean production leads to raising the morale of workers as a result of seeing manufacturing processes go according to the technique of lean production	0.604
1	In lean production, accumulated production that is more than the customer demands is avoided	0.571
2	Lean production provides an opportunity to avoid the wait period resulting from the end of a process and start of a subsequent manufacturing process.	0.550
4	Lean production reduces the time spent on quality tests.	0.518

Table (9) shows the variables of the first group, arranged according to the degree of saturation of each variable, which according to the degree of correlation of the variable with the group, in other words, this analysis arranges the importance of the questions of this axis based on the answers of the research sample and not based on their arrangement in the questionnaire.

Also, the table shows that five variables or questions out of a total of six questions from the lean production axis have an effect on reducing the costs of the product. It is arranged in ascending order of saturation or effect**,** starting from 0.672 for first variable in this group and ending in 0.518 for the last variable at same group. This shows the other variables have weak effect and the degree of their saturation or impact has less than 0.5. Thus, for the rest of the six groups, the degree of saturation or influence varies within the same axis and also for the rest of the research axes.

7.7.3. Analysis of the correlation between the independent and dependent variables.

Statistical analysis shows the strength of the correlation between the independent variables (X1, X2, X3) represented by lean production and robot and total quality management (TQM), respectively, with the dependent variable (Y) represented by reducing the cost of the product, since correlation coefficient is 0.755, 0.715, 0.710 respectively for the above three independent variables. The analysis shows the strength of the relationship between the independent variables mentioned above and the dependent variable, as the relationship is strong whenever it is 50% or more, and it is weak whenever it is less than 50%.

Table (10) shows the regression coefficient or degree of impact, as well as the square of the coefficient of determination or the ratio of the influence of the above independent variables to the dependent variable, as follows:

Table (10)

Table (10) shows the squared coefficient (R2), the Regression coefficient (B), t-calculation and table, f-calculation and the nature of the relationship between the independent and dependent variables.

Independent variables	R2	Regression Coefficient B	t- calculation	t- table	f- Calculation	Nature of relationship
X1	0.570	0.602	4.601	2.681	7.188	Significant
X2	0.511	3.714	4.491	2.194	4.813	Significant
X3	0.504	0.116	4.875	2.088	4.355	Significant
Total X	0.526	0.573	4.343	2.079	4.320	Significant

From Table (10), the total regression coefficient of the independent variables of lean production (X1), robot (X2), total quality management (X3) is 0.573 and this means that the independent variables have a strong impact on the dependent variable (reducing the cost of the product), as the higher the Regression coefficient, means an increase in the strength of the effect of the independent variables on the dependent variable. That is, the entity unit can reduce the costs of its products when modern technologies are adopted in production. Likewise, the coefficient of determination shows the ratio of the impact of each of the independent variables on the dependent variable as the ratio of the impact of lean production, robot and total quality

management on the dependent variable (reducing the cost of the product) amounted to 0.570, 0.511, and 0.504 respectively. As for the complete percentage, it returns to the influence of other unknown factors. Also, table (10) shows the nature of the relationship between the independent variables and the dependent variable, which is significant as in the table above. There is a significant moral effect of the independent variables on the dependent variable (reducing the cost of the product).

8. Conclusions and Recommendations.

8.1.Conclusions.

1- The Iraqi manufacturing environment at the present time is somewhat far from adopting modern production techniques with the exception of some applications of total quality management represented in achieving ISO conditions in some companies. This shows clearly the inability of the Iraqi manufacturing in most sectors to compete with the foreign product in its cost and quality, and in particular product design. The researcher also noted the lack of American goods in the Iraqi market, except for cars and medicines

2- The statistical analysis shows, as in Table (4), the weight mean of the lean production axis (4.48) as well as the standard deviation (0.78102) of the research sample. This means that the research sample is consistent with what the researcher expected, that lean production reduces the costs of the product when the lean production technique is used effectively.

3- Table (10) shows that the total square of the coefficient of determination reached its percentage (0.526) or 52.6%, reflecting the percentage of the total impact of independent variables (lean production, robots and total quality management) on the dependent variable (reducing product costs), and that for the total regression coefficient of the variables the independent group reached (0.573) or 57.3%. This reflects the degree of influence of these variables on the dependent variable.

4- The researcher noted that many international companies (Japanese and American) have moved some of their factories to countries with low operating costs such as China, even though these companies are technologically advanced and use the best modern production technologies. Those who visit the USA find that the goods produced in China have invaded the market due to price competition and the relatively low cost of production in China.

8.2. Recommendations

1- The results of the analysis clearly indicate the importance of developing the manufacturing environment in Iraq if the manufacturing companies want to compete with foreign products, and in order to be like that, modern technologies in production must be introduced, enabling them to restore the market share it lost in favour of the foreign product.

2- The manufacturing environment is not limited to purchasing modern machines and equipment, but also means preparing and training the staff and changing work methods in a way that achieves the element of competition and economic feasibility for Iraqi manufacturing.

3- The industry is no longer simply producing, selling and meeting customer requirements. Rather, it contributes to changing the pattern of the Iraqi economy and shifting from a one-sided economy to a balanced economy in order to avoid to a large extent the sharp drop in oil prices, and this issue is of paramount importance to the country.

4- Based on what came in the statistical analysis in Table (10) with regard to the regression coefficient, the determination factor and the nature of the moral relationship, the researcher stresses the importance of adopting the Iraqi industry, including the service industry, with modern technologies in production because it contributes to reducing the cost of production and improving the quality of products. It meets the desires and needs of customers and greatly improves the competitive position of the Iraqi industry.

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