

The applicability of lean manufacturing methods and its impact on the performance of the Jordanian industrial companies listed in ASE

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ABSTRACT

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This study aims to cast the light on the impact of lean manufacturing on performing Jordanian public shareholding industrial companies listed in ASE. Data were collected and developed through a questionnaire built on the basis of previous studies. The number of companies that answered the questionnaire questions was 38 companies out of 45 companies, which means that the percentage of the study sample reached 84.44% of the study community. The results showed that lean manufacturing has an impact on the performance in its three dimensions; namely operational, financial, and the environmental. The improvement of operational, financial and environmental performance, as a result of applying lean manufacturing method was optimized to 9.2%-11.8%. In fact, the pharmaceutical industries were the most sectors that apply the lean manufacturing method, followed by food industry companies and then chemicals companies, which were the lowest sector that applies lean manufacturing method.

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1. Introduction

The industrial sector in Jordan is the main pillar of economy, as it has the most important role and significant impact on the economic development of any country at the local and international levels (Matar & Unaizat, 2018). The fact-moving world and global competition led companies to achieve their performance to focus on cost and quality. Therefore, companies compete for quality management to improve performance efficiency in terms of operational, financial and environmental. Manufacturing firms is facing a number of severe problems, such as global ecological damage, resource wastage and shortage, environmental pollution and discretionary exploitation of natural resources, which all significantly affect production cost (Golroudbary & Zahraee, 2015). Company efficiency and competitiveness are two important challenges that have motivated many manufacturing firms to plan new management strategies (Holweg, 2007; Zahraee et al., 2014). The role of lean manufacturing method is highlighted in improving the quality of services and products that are provided by companies by reducing costs, discovering wastage of different forms. Thus, disposing such wastage through the continuous development of processes are implemented and applied by the facility and they are reflected off improving the products and services provided and the environmental performance of industrial companies. The lean manufacturing method has a prominent role in the results of the major industrial companies located in Japan and the United States of America (Nawanir, Teong, & Othman, 2013). This prompted many industrial companies around the world to strive for adopting this method. Lean manufacturing is the backbone of efficient industrialization and its importance lies with industrial companies by turning waste into profit (Saleh, 2015). Therefore, industrial companies must identify the waste and its nature at every stage of manufacturing and propose accurate

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solutions to disposal and thus improve the company's profitability (Marguarossian, 2017). Whereas many researchers emphasized that the lean manufacturing method is based on the use of methods and practices that work to get rid of waste in a different way, in time or resources, and therefore it can be said that the optimal use of the company's resources contributes significantly to improving performance (Nawanir et al., 2013). Due to the current competitive, trading situation and the significant increase in the cost of raw materials, many industrial companies follow methods and programs aimed at reducing waste and costs to a minimum due to its direct impact on the profits in those companies (Marguarossian, 2017). The Jordanian industrial sector suffers from a major problem represented by high production costs, in terms of higher prices of raw materials, energy, taxes, fees, transportation, freight and labor scarcity. This is the biggest problem for the national industry at the current stage, and the most prominent and rapid challenge that affects any investor in the industrial sector (<https://maqar.com/2019/04/22/>). Mining is the most exporting industrial sector, followed by the chemical and cosmetic industries sector, then the leather and textile industries sector. The industry has an economic importance due to its role in increasing national exports abroad, in addition to the positive and direct economic effects of exports on the national economy. No doubt, exports contribute to increase foreign reserves in the central bank; which means maintaining the value of the dinar and controlling inflation rates in addition to increasing the ability of the central bank to control the levels of liquidity in the market and offer money (<https://www.almamlakatv.com/news>).

The main objective of this study is to determine to which extent public joint-stock industrial companies listed in the Amman Financial Market applies lean manufacturing methods and their impact on performance (its operational, financial and environmental). It also aims to know the extent of applying lean manufacturing methods in public joint-stock industrial companies listed on the Amman Financial Market. It is necessary to know the problems facing the application of lean manufacturing in companies, in order to indicate the degree to which the requirements of lean manufacturing are applied in the public industrial companies listed on the Amman Financial Market and to identify proposed conclusions to propose certain recommendations that can help the companies integrate lean in manufacturing application.

2. Literature Review

Among the key concepts that help managers sustain competitiveness in an expanding global market is the lean manufacturing (LM) practices and tools. "Lean" means manufacturing without waste. Lean manufacturing or lean production started at Toyota Corporation with names such as "on-time" manufacturing or "Toyota production system". Lean Manufacturing describes the profound revolution launched by Toyota against the mass production system. Lean manufacturing is turning into more than just technology. It is a way of thinking and a whole system approach that creates a culture in which everyone in the organization constantly improves processes (Taj, 2008). Therefore, many studies have sought to discover the relationship between lean manufacturing methods and corporate performance in order to reach a comprehensive and clear image of that relationship. Thus, the importance of studying this relationship stems from the impressive results achieved by Toyota as a result of using the lean manufacturing method of despite the existence of difficult economic conditions for the country of Japan where Toyota was operating. From this point, lean manufacturing has become the focus on attention on many researchers and other industrial companies. The methods of the researchers varied from studying the relationship between lean manufacturing methods and performance, whether for large companies, small or medium-sized companies (Hu, Mason, Williams, & Found, 2015), and it seems that there is a clear difference with the studied lean manufacturing methods and showing their impact on the different types of performance, whether financial, operational or environmental. Moreover, this diversity and difference in the methods used to measure the methods of applying lean manufacturing may be a reason not to assert that lean manufacturing methods to improve the performance of companies. In addition to the unclear relationship between the different types of performance, this is obvious by following up some studies to know whether operational performance (such as quality, inventory, productivity, and cost) mediates the relationship between lean manufacturing methods and operational performance (profitability, sales, customer satisfaction) (Nawanir et al., 2013). There is also an emphasis on the fact that lean manufacturing methods increase in size, with companies focusing on the use of non-traditional indicators (Fullerton & McWatters, 2002) since conventional financial indicators cannot be relied on, alone, to detect any undesirable indicators of deviation during the application of lean manufacturing methods. Therefore, it is necessary to use non-traditional indicators such as quality and link them with rewards given to the employees to ensure that lean manufacturing methods are properly applies. Although the lean manufacturing methods are applied well and the financial and non-financial indicators are used to avoid any deviation during the application of the manufacturing methods, but the relationship between lean manufacturing methods and performance is still not clear to some companies. The reason may be the existence of obstacles that hinder the improvement of the companies; such as non-allocating resource for lean manufacturing application methods and the lack of senior management participation in applying lean manufacturing methods, in addition to the prevailing culture in the company (Jadhav, Mantha, and Rane, 2014). The following are the most notable studies that have included lean manufacturing methods, both in Jordan and abroad for industrial companies. The aim of the study conducted by Hasan and Al-Zu'bi (2014) was to evaluate the relationships between the dimensions of lean manufacturing and radical innovation of products of Jordanian pharmaceutical sector. The results of the research showed the humanitarian aspect of the radical innovation and clarify a different direction for the relationships between the dimensions of lean manufacturing and root product innovation based on these tests. Several recommendations have been proposed, including increased staff participation in production decision-making process to enhance their capacity for innovation. The purpose of the study conducted by Smadi (2012) was to identify the extent of applying lean supply practices in the Garments manufacturing companies in Jordan. The study revealed that the Garments Manufacturing

Companies in Jordan adoption to the lean supply practices is considerably high at all aspects, with the exception of the development of suppliers with an average rating. Baqlah (2017) sought to explore the impact of organizational culture on lean technical practices in Jordanian manufacturing companies. The results of this study concluded that the hierarchical culture has the highest significant positive impact on lean technical practices, followed by development culture, collective culture and rational culture respectively. It also was found that each type of organizational culture (group, developmental, hierarchical and rational) positively affects lean human practices (customer engagement, employee participation, and supplier participation) at different statistical levels.

The study of Zahraee (2016) aimed to find out the effective practices and tools of lean manufacturing implementation in an Iranian factory. The results of his study emphasize some implications and suggest that the lower cost is more effective and decreased inventory is less effective on lean manufacturing implementation. The final results also showed that processes, equipment, planning, control, supplier relationship, human resources and customer relations are significant practices in lean manufacturing in Iranian manufacturing factories. The results of this study additionally show that lean tools such as Kaizen, 5S, setup time reduction, cellular manufacturing, continuous flow, equipment layout, product design simplicity and error proof equipment are essential to the implementation of lean manufacturing. Several studies examined financial performance, such as the study of Alaaraj and Bakri (2019). This study examined the impact on lean manufacturing on financial performance from the perspective of managers in the industrial sector in southern Lebanon. The results concluded that lean manufacturing had a significant and positive impact on the financial performance. The study of Nimeh et al. (2018) aimed to study the effects of lean supply chain management practices on supply chain performance and the market performance of manufacturing companies in Jordan. Five practices were identified based on a comprehensive literature review: timely order, information flow, supplier relationship, customer relationship, and waste reduction. The results revealed the positive and important effects of three practices on market performance; namely, timely order, information flow, and customer relationship. Practices have demonstrated positive and important impacts on supply chain performance. Moreover, supply chain performance has shown a positive and important impact on market performance. The study of Shrafat and Ismail (2019), for the operational performance, examined lean manufacturing practices in an experimental manner and determines their impact on business performance, focusing particularly on the role of mediation in operational performance and determines the lean manufacturing practices best suited to the application. The study was conducted on the industrial companies' sector in Jordan. The variables were adopted, timely withdrawal of production and supply, control of statistical operations, and preventive maintenance. The study found a positive effect of implementing lean manufacturing practices on both operational and business performance. The goal of the researchers, Ahmed and Khashman (2018) was to know the impact of lean practices on productivity in the process industries and concluded that labor standards had a significant impact on productivity while reducing waste did not have a significant impact.

The study of Al-Zu'bi (2015), examined the effects of four basic and internal practices on flexibility performance in Jordanian manufacturing companies. Lean practices included reducing preparation time, continuous improvement, process synchronization, system withdrawal. The hierarchical regression analysis showed that lean production had a positive and significant impact on the performance and flexibility. All lean practices demonstrated to be positively and effectively linked to the performance and flexibility. The leanest practice was to contribute synchronization of operations followed by a system of drag and continuous improvement. The effect of environmental moderation was also examined dynamics. The results of the interaction terms showed that the environmental dynamics were largely positive and correlated with process synchronization and performance and flexibility. The study of Al-jawazneh (2015) examined the effect of internal graceful dimensions on the manufacturing quality of food processing companies in Jordan. Variables such as drag systems, continuous flow, reduced setup time, overall production maintenance, statistical process control, and employee engagement were represented to represent the internal graceful dimensions. It was supposed to have an impact on the existing manufacturing quality. The results of the study showed that internal graceful dimensions have a significant impact on the quality of manufacturing-based products, which is manifested in reducing the less reprocessing of food products. It is in line with high quality standards, lower defects, and less frequent malfunctions that have helped food manufacturers to provide their products in accordance with the agreed schedule and optimize their manufacturing resources, such as machinery, equipment, raw materials and manpower.

El-Khalil and Farah (2013) examined the degree of lean production in manufacturing factories in the Middle East and their impact on operational standards. The study included the lean dimensions investigated for "Seven Wastes", standardization, maintenance of total productivity and supplier (performance), problem solving, monitoring of the statistical process, improving or reducing overall quality management, system mapping (on demand), and customer requirements or needs. The result of implemented dimensions of lean indicates that while most of the respondents have scored between 40-59% levels, only very few are above 60% levels and none of the companies has scored above 89% implementation levels. The study indicates that the operational performance has improved on all measures except space reduction. In addition, respondents have noted that reducing cost conversion, increasing productivity, and reducing inventory were the three main drivers of lean implementation. For the environmental performance, the study of Garza-Reyes et al. (2018) examined the impact of five simple basic methods; such as on-time production, continuous improvement, and overall productive maintenance on compliance with environmental performance (materials used, energy consumption, and pollutant release). The results indicate that TMP and JIT had an impact on environmental performance, while continuous improvement showed an effect only on material use and pollutant release and independence, while VSM had no impact on environmental performance.

3. Problem of the Study

Many researchers have focused on studying the relationship between lean manufacturing and its impact on corporate performance in developed countries, but there is still an urgent need by researchers to focus on this relationship (Nawanir et al., 2013). In addition, there is great interest in discovering and studying this relationship between small and medium-sized companies (Hu et al., 2015). Although there are many studies that emphasize the importance of lean manufacturing methods in improving financial performance, this result is still in doubt due to the existence of some studies that showed that the financial performance of companies has not been improved as a result of using lean manufacturing methods (Ahmad, Mehra, & Pletcher, 2004). As for operational performance, there is still an urgent need also to discover the impact on the use of lean manufacturing tools on the operating performance of companies, in addition to knowing the improvements achieved by companies because of using lean manufacturing methods (Hu et al., 2015). Hence, the problem of the study is trying to show the extent of the researched companies applying lean manufacturing methods and knowing the effect of applying lean manufacturing methods on performance.

4. Importance of the Study

The importance of the study stems from demonstrating to what extent the lean manufacturing could reduce production costs, maximizing the profitability of companies, and identifying the reality of industrial companies. Furthermore, to know the extent of their compliance with technological developments by taking advantage of global experiences towards the application of modern systems in the field of production and operations management, including lean manufacturing.

5. Research Methodology

5.1 Study Model

This study aimed to determine the extent of the lean manufacturing method applied by industrial companies and what level of application, and whether the level of lean manufacturing methods applied improves the financial performance, operational performance and environmental performance of industrial companies. Fig. 1 herein below shows the Model Study

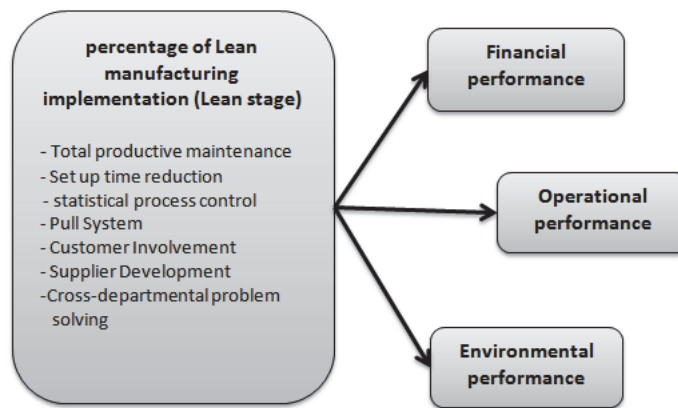


Figure 1: Study Model

The study model has been built on the basis of previous studies, as there are many studies that have examined the impact of lean manufacturing methods on the performance of companies, but the results of previous studies were different. Some of them focused on the financial performance only, and some focused on the operational performance only, and some studied the relationship on the financial and operational sides. Thus, this study came to include the different types of performance in addition to environmental performance of the industrial companies. Hence, this study came to find out whether the higher the level of lean manufacturing methods applied leads to an increase and improvement in performance (financial, operational and environmental). The study of Ghosh (2013) aimed to measure the level of application of the lean manufacturing method. As the lean manufacturing method included measuring seven aspects: Suppliers' Feedback, Focus on customer needs, Pull System, Setup time reduction, Total productive maintenance, Statistical process Control, and Cross-departmental problem solving. A set of questions was placed on each of these aspects, each question was measured using a five-point Likert Scale ranging from 5 to 1, so that 5 means that it is fully implemented, and 1 means not applied. Calculating the extent to which each aspect of lean manufacturing is applied, the rate of answers to questions is calculated for each side to reach the extent to which each side is applied such as suppliers' feedback, etc. To calculate the lean manufacturing method as a percentage of 100, the answer rate is grouped for each of the seven aspects and then divided into 35 to extract the percentage. The reason for this is that each of the seven sides is seven in the event that it is fully applied will be 5 and since there are seven aspects then its total is 35. Therefore, if we assume that the sum of the seven sides to apply the lean manufacturing method was 35,

and then it means that the company applies lean manufacturing method 100%, but if the sum of the seven sides 21 out of 35, this means that the company applies the lean manufacturing method by 60%. Thus, the level of application of the lean manufacturing method passes through five stages based on the percentage of its application. It is either not applied or the applied at low rate, or there is an application but it is applied in a large scale and finally applied completely, so that the application rate for the previous five stages is almost and close to 0%, 25%, 50%, 75% and 100%, respectively (Ghosh, 2013). As for the dependent variables related to financial, operational, and environmental performance, the following previous studies (Alaaraj & Bakri, 2019; El-Khalil & Farah, 2013; Garza-Reyes et al., 2018) were used in their selection and method of measurement. With regard to financial performance, both the return on investment, the percentage of growth in sales or revenue, and finally the percentage of growth in net income were chosen. As for the operational performance, the productivity enhancement, quality-first pass correct output, inventory reduction, lead time reduction, and finally conversion cost reduction were chosen. As for environmental performance, the variables used in this study are three variables: energy saving, non-product output, release pollution. Thus, all previous dependent variables (i.e. performance, whether financial, operational, or environmental) were measured by asking about the extent of improvement or reduction in them by relying on a scale ranging from 0 to 100% so that the improvement of each variable increases by 5%, in other words the scale starts from 0%, 5%, 10%, 15% 100%.

5.2 Questions and Hypotheses

This study seeks to find out whether the level of lean manufacturing by industrial companies has increased, and whether this rise has increased and improved the financial, operational and environmental performance of these companies using a simple linear regression analysis between the level of lean manufacturing and performance variables. Therefore, this study seeks to test the following hypotheses:

First key questions: What is the level of lean manufacturing in the companies in question?

The first main hypothesis (H₁): What is the impact of applying the lean manufacturing on the financial, operational, and environmental performance of the companies examined? It is divided into the following sub-hypotheses:

The first sub-hypothesis (H₁₋₁): The higher the level of application of the lean manufacturing method, the better the financial performance of the industrial companies listed on the Jordanian financial market.

The second sub-hypothesis (H₁₋₂): The higher the level of application of the lean manufacturing method, the better the operational performance of the industrial companies listed on the Jordanian financial market.

The third sub hypothesis (H₁₋₃): The higher the level of application of the lean manufacturing method, the better the environmental performance of the industrial companies listed in the Jordanian financial market.

5.3 Study Sample and Data Collection

This study aims to measure the level of application of the lean manufacturing method by industrial companies listed in the Jordanian financial market. According to the activity, the industrial companies listed on the Jordanian financial market are divided into 8 groups: the pharmaceutical, chemical, food, extractive, engineering, construction, electrical, clothing, leather, and finally Tobacco and cigarettes industries. The questionnaire was prepared using Google Drive, and the link was emailed to the senior officers of those companies, and the data that was relied on in the analysis was collected within 3 months starting November 2019 and ending with January 2020. 38 companies out of 45 companies responded, which means that the respondent's percentage was 84.44% of the study community. Table No. 1 shows the number of companies that responded for each group within the industrial sector

Table 1
number of companies in the sample classified within industrial sectors

Industrial sectors	Number of companies in the sample	Number of company in ASE
Pharmaceutical and Medical Industries	4	4
Chemical Industries	7	7
Food and Beverages	8	8
Mining and Extraction Industries	5	10
Engineering and Construction	8	8
Electrical Industries	3	3
Textiles, Leathers and Clothing's	3	3
Tobacco and Cigarettes	0	2
Total	38	45

Thus, industrial companies working in the food, construction and engineering industries received the largest proportion of sample; each represents 21% of the total industry sector of the sample. For companies engaged in textiles, leather and electric field reached 8% each, respectively, representing the lowest percentage of study sample. Fig. 2 shows the proportion of companies distributing according to their activity.

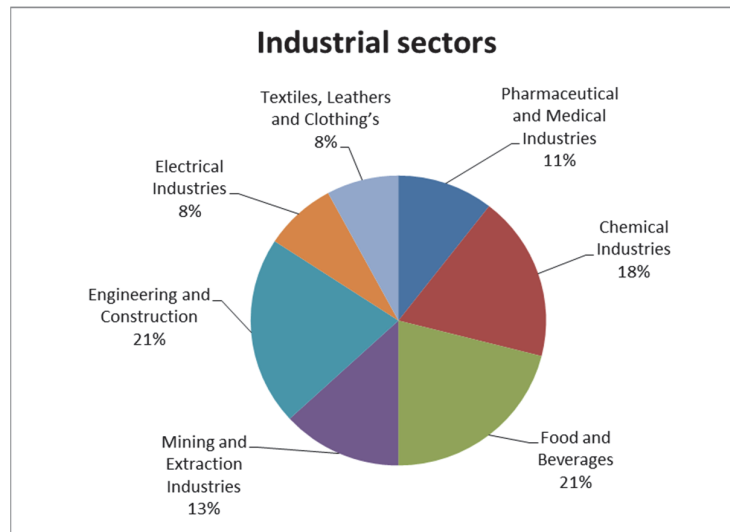


Fig. 2. Percentage of each industrial sector in the sample

This study is based on previous studies to build study questions, but this is not enough for unity, especially the previous studies had different ways of measuring variables. Therefore, the validity and reliability of the study questions were verified specialized academics with considerable experience in lean manufacturing method. Their comments were considered and consequently the study questions have been modified prior delivered to the industrial companies. Moreover, the managers of industrial companies who had experience in this area reviewed the final wording and accordingly, their comments were appreciated and included.

6. The Results

6.1 Descriptive Statistics

Table 2 represents the values of the Cronbach Alpha coefficient to measure the reliability of the questionnaire for all the paragraphs and the paragraphs of each axis separately.

Table 2
Cronbach's Alpha

	Cronbach's Alpha	N of Items
All Questions	.937	43
The first axis	.869	4
The second axis	.888	3
The third axis	.876	5
The fourth axis	.765	4
The fifth axis	.737	6
The sixth axis	.497	6
The seventh axis	.701	4
The eighth axis	.955	11

Table 3
Descriptive statistics

	Minimum	Maximum	Mean	Std. Deviation	Ranked
percentage of Lean manufacturing implementation (Lean stage)	0.30	0.72	0.5597	0.08304	1
Return on investment (ROI)	0.00	0.35	0.1145	0.08046	4
percentage growth of sales/revenue	0.00	0.40	0.1184	0.08809	2
percentage growth of net income	0.00	0.30	0.1053	0.06554	7
Increase of Productivity	0.05	0.35	0.1171	0.07647	3
Increase of quality-first pass correction output	0.05	0.30	0.0974	0.06035	11
inventory reduction	0.05	0.25	0.1026	0.05689	9
lead time reduction	0.00	0.30	0.0921	0.06929	12
conversion cost reduction	0.00	0.35	0.1132	0.07230	5
Saving energy	0.00	0.30	0.1000	0.05452	10
non-production output reduction	0.00	0.35	0.1039	0.07202	8
pollutions reduction	0.00	0.30	0.1105	0.06592	6

Table 3 shows the lowest and highest value, the mean, and the standard deviation of the study dimensions. From the above table, we find that the lowest percentage for applying the lean manufacturing method was 30% and the highest value was 72%, which means that industrial companies in Jordan apply lean manufacturing method. It ranges from low to wide application. With regard to the rate of improvement, whether for financial, operational or environmental performance resulting by applying the lean manufacturing method, it ranged between 9.2% to 11.8%.

Table 4

Descriptive statistics for lean manufacturing implementation to each sector

Industrial sectors	Minimum Lean implementation	Maximum Lean implementation	Average Lean implementation
Pharmaceutical and Medical Industries	48.33%	72.29%	61.38%
Chemical Industries	48.86%	65.71%	59.80%
Food and Beverages	49.29%	68.14%	60.82%
Mining and Extraction Industries	49.05%	50.10%	49.26%
Engineering and Construction	45.62%	55.48%	52.98%
Electrical Industries	45.62%	55.48%	50.40%
Textiles, Leathers and Clothing's	30.00%	62.38%	51.59%
All Industrial sectors	30.00%	72.29%	55.18%

The sample of the study varied by involving industrial companies operating in various industrial fields, such as the pharmaceutical and food industries, etc. This opportunity allows us to compare between companies in the industrial sectors in terms of the level of application the lean manufacturing method. From Table No. 4, we find that the clothing and leather industries sector had the lowest application rate for lean manufacturing method, which is 30%. Companies operating in the pharmaceutical industry have the highest application rate compared to other industrial sectors. Table 4 also shows that the rate of application of the lean manufacturing method among companies belonging to the same industrial sector. From this scale we find that the pharmaceutical industries were the most sectors that apply the lean manufacturing method, followed by companies work in food industries and then companies that work in industries as chemical companies, which is the lowest sector that applies lean manufacturing method.

6.2 The effect of lean manufacturing implementation score on companies' performance

As shown in Table 5, the results of the study hypothesis test showed that the higher the level of application of the lean manufacturing method, the greater the performance (financial, operational and environmental). The first hypothesis aims to test whether there is a relationship between the level of lean manufacturing method application and financial performance. For testing this hypothesis, a simple linear regression analysis was performed between the level of lean manufacturing application and three variables of financial performance (return on investment, revenue growth rate, net income growth rate). Each of the three variables was tested separately.

Table 5

Simple regression results between the lean and performance

	Constant	coefficient of Lean implementation percentage/stage	R ²	t-value
Financial performance:				
Return on investment (ROI)	-0.070	0.330**	0.116	2.175**
percentage growth of sales/revenue	0.132	-0.025	0.001	-0.140
percentage growth of net income	-0.057	0.289**	0.134	2.362**
Operational performance:				
Increase of Productivity	-0.062	0.320**	0.120	2.221**
Increase of quality-first pass correction output	-0.088	0.331***	0.208	3.071***
inventory reduction	-0.070-	0.308***	0.202	3.020***
lead time reduction	-0.193***	0.510***	0.374	4.637***
conversion cost reduction	-0.034	0.263*	0.091	1.900*
Environmental performance:				
Saving energy	-0.133-***	0.417***	0.403	4.930***
non-production output reduction	-0.084	0.336**	0.150	2.523**
pollutions reduction	0.038	0.129	0.026	0.990

Notes: significant at: * $P < 0.1$, ** $p < 0.05$ and *** $p < 0.01$; $n = 38$

The results of the test between these among those variables showed the higher the level of application of the lean manufacturing method, the better the return on investment and the growth rate of net income, which is a statistically significant relationship. As for the rate of growth in revenue, there was no statistically significant relationship. It can be said that the application of lean manufacturing by industrial companies has improved the financial performance (return on investment and growth in net income) except for the rate of growth in revenues. The reason for the lack of improvement in the rate of growth in revenues may be because the industrial companies have not fully implemented the lean manufacturing method, focusing on reducing costs and reducing waste only. The results of testing the second hypothesis showed that the higher the level of application of the lean manufacturing method, the greater the level of operational performance of the companies. All variables of operational performance (increase productivity, increase of quality-first pass correction output, inventory reduction, lead

time reduction, conversion cost reduction) were statistically significant, and the lean manufacturing strategy improved them. Thus, the improvement in the operational performance of companies confirms that the philosophy behind the lean manufacturing method has succeeded in reducing costs and has led to an increase in the quality of services provided by industrial companies. The results of testing the third hypothesis of this study showed that the greater the level of lean manufacturing method application, the better environmental performance of industrial companies with only two variables; namely energy saving and non-production output reduction, which are statistically significant. The lean manufacturing strategy has had no impact on reducing environmental pollution. Therefore, it can be said that the lean manufacturing method contributed to the rationalization of energy use and worked to reduce industrial waste, i.e. this method led to achieving the optimal use of resources in industrial companies. However, lean manufacturing method has not yet reached the stage of reducing environmental pollution.

7. Discussion

Lean manufacturing is one of the modern concepts used in Jordanian and international industrial companies. It had a great impact on improving the performance and practical efficiency. Through the general survey of studies that were reviewed, we did not find applying the concept of lean manufacturing in its three dimensions (operational, financial and environmental performance) in the industrial organizations. This study adopts the extent of applying lean manufacturing methods of performance (operational, financial and environmental). This study shows the extent to which lean manufacturing methods are applied in Jordanian industrial companies and the degree of their impact on the performance in its three dimensions (operational, financial and environmental) adopted in industrial companies. The study indicates that many of the results for industrial companies in Jordan have achieved an advanced level of performance and achieved high operational performance through the application of lean manufacturing methods, but with regard to the financial performance, the results were satisfactory. The results were consistent with an acceptable percentage in terms of environmental performance. The results of this study, in terms of the extent to which the lean manufacturing is applied to the operational performance, are in consistent with some studies (i.e. Ghosh, 2013; Ahmed & Khashman, 2018; Shrafat & Ismail, 2019). The results of this study in terms of the extent of lean manufacturing applied to the financial performance were in consistent with some studies (i.e. Alaaraj & Bakri, 2019). The results of this study in terms of the extent of lean manufacturing applied to environmental performance were in consistent with some studies (e.g. Al-Zu'bi, 2015; Ou Tang, 2018). The findings of this study are valuable to those who are working in industry and wishing to implement the lean manufacturing methods in their business. It also could be useful for organizations to identify factors that impact lean manufacturing implementation. This research should also be useful to an intellectual in future studies.

8. Conclusion

Manufacturing industries are trying to find new ways to decrease production cost, eliminate waste, increase product quality, enhance productivity and improve customer satisfaction. All of these can be obtained through implementing LM approaches in industry. The LM methods and traditional manufacturing have shown inadequate support to the manufacturing industry in order to achieve world-class production systems. The manufacturing industry should aim to adopt LM thinking, practices and tools in the key area of production. Moreover, the manufacturing industry should consider introducing appropriate lean education, training and professional development. There is a relationship between the level of lean manufacturing method and financial performance, where there is a relationship between the level of lean manufacturing application and between three variables of financial performance (return on investment, the rate of growth in revenue, the percentage of growth in net income). The higher the level of application of the lean manufacturing method, the greater the level of operational performance of the companies, and all the variables of operational performance (increase productivity, increase in quality-first pass correction output, inventory reduction, lead time reduction, conversion cost reduction) are statistically significant. Therefore, the presence of improvement in the operating performance of companies confirms that the philosophy that supports it. Lean manufacturing has succeeded in reducing costs and has led to an increase in the quality of services provided by industrial companies. The higher level of the lean manufacturing method applied, the better environmental performance of industrial companies, but only in two variables; energy saving and reducing non-productive production, which are statistically significant. Lean manufacturing strategy has had no impact on reducing environmental pollution. However, lean manufacturing has not yet reached the stage of reducing environmental pollution. The current research results support that the manufacturing industry, especially in Jordan, ought to improve lean thinking and approaches to sustain in a competitive environment. This study also created awareness to researchers regarding the role of LM methods and techniques in boosting production benefits. Further studies can be conducted to evaluate various barriers in the implementation of lean accounting by considering cultural, technical, organizational and economic factors in manufacturing companies. Attention should be paid to a comparative study of the extent of lean manufacturing for small and large companies, and expand research on the impact of lean manufacturing on environmental performance. The findings may be important to industries who desire to implement the LM process in their business and for organizations to identify factors that impact lean manufacturing implementation. This study also created awareness to researchers regarding the role of LM methods and techniques in boosting production benefits. Further studies can be conducted to evaluate various barriers in the implementation of lean accounting by considering cultural, technical, organizational and economic factors in manufacturing companies.

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