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An integrated model of lean manufacturing techniques and technological process to attain the competitive priority

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C H R O N I C L E

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A B S T R A C T

This research paper intends to contribute to the overall understanding of the relationship between Lean Manufacturing techniques and the achievement of Competitive Priority, including continuous improvement, comprehensive manufacturing maintenance, cellular manufacturing, rapid installation / quick changeover and Five-S-Workplace Organization, by analyzing the role of the technological process as a mediating factor. This study aims to evaluate the impact of these factors on competitive priority through evaluating the technological process as a mediating factor in clothing companies listed on the Amman Stock Exchange, which is considered as one of the important industrial sectors in Jordan. A random sample was applied to the population of this study consisting of all executives, department managers and employees specialized in operating companies. A total of 156 questionnaires were collected and analyzed using the Smart Partial Least Square (PLS) technique, which depends on the Structure Equation Modeling approach. Based on the findings of the statistical analysis, it has been concluded that the lean manufacturing techniques impact on competitive priority. The indirect effect of process technology on the relationship between Manufacturing Techniques and competitive priorities was considered to be statistically significant. The results also show that the direct effect value of the Manufacturing Techniques variable on the competitive priorities (dependent) variable (in the presence of mediator) was (0.353). The study recommends the deployment of Spread the philosophy of lean manufacturing for all organizations and use modern technology to improve productivity.

1. Introduction

Nowadays, to adapt to market and environmental changes, most of the organizations started to implement manufacturing initiatives such as lean and agile approaches (Hallgren & Olhager, 2009). Lean manufacturing (LM) was practiced and developed for the primary time in Toyota Motors Japan to maximize worth and scale back waste within the producing system (Kumar & Kumar, 2015; Stevenson, 2010). In this line, (LM) is known as new system recently implemented in many organizations, which primarily aimed at reducing unnecessary spending and eliminating non-value-added activities in the supply chain. In other words, lean manufacturing is capable of accomplishing activities and operations of the entities continuously to obtain a faster response to customers, meanwhile increasing the quality level. For that purpose, it deploys a range of analytical methods and techniques as well as specific instruments that allow the flow of value in the sense of logic of continuous improvement. In short, lean manufacturing is generally seen as a possible technique for increasing efficiency and reducing costs in manufacturing organizations (Sanders et al., 2016). However, the term agile refers to manufacturing methodology, which uses inputs to create the same outputs that can be developed with the vast conventional production system. As such, being lean means using a few human resources, factory equipment, and limited production capacity, thereby spending less on developing the new product and with short lead times. In essence, lean manufacturing is not limited to a collection of methods

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and tools; instead, it is an integrated manufacturing strategy that encompasses the manufacturing processes within the enterprise. Basically, the strategic dimensions of agility start from receiving the new components of the equipment, then the procedures, and the applicability of the operations before delivery to the customer.

Lean manufacturing involves growth, supply chain, customer relations, and product development; these approaches together form the agile organization or the agile project (IBM, 2005). In the organizational context, lean manufacturing comprises concentrating on waste reduction (or removal of it, while at the same time trying to gain maximum benefit from value-added activities). For the consumer, the price can be determined by the perceived value, which is equal to anything that the customer is willing to pay in exchange for a product or the following service.

Further, the term lean manufacturing describes the method that uses fewer inputs to produce the same results as those that could be produced using the conventional production system. Recently, it is used as a synonym for a group of words that have emerged recently, such as efficient manufacturing, global manufacturing requirements, concurrent manufacturing, and continuous flow (Tinoco, 2006). Ultimately, lean manufacturing seeks to reduce the company's labour force, stock, defective products, the occupied area of the factory, cycle time, scrap, and rework costs while at the same time contributing to improved efficiency, quality, and production. Such a reform, which would save time and energy in the plant, will include control and enhancement of the product quality whereby stock can have a negative factor at all levels, and therefore should be tightly controlled (Chase, 2001; Cengiz, 2012; Johansson & Osterman,2017).

Historically, lean manufacturing emerged after the second world war in Japan, primarily at the car firm Toyota, in response to a mixture of setbacks that hit the Japanese industry. As a result, various difficulties in producing high-quality goods to address the void shortage in the local Japanese market has emerged (Pyzdek, 2000). According to Daniels et al. (2009), manufacturing is a production system that focuses on improving processes through a continuous process of change by eliminating unnecessary activities that do not add value to operations and minimizing the required effort in each part of the work. In this vein, Schroeder (2007) advocated that agile manufacturing is a type of production systems that use fewer inputs, taking into account the diversity in the product offered to the customer. Similarly, Omoush (2020) elucidated that operational performance may be augmented by incorporating the consumer on pertinent matters like quality and material flows, resulting in faster and more precise delivery of results. Overall, Kumar et al. (2014) stated that lean manufacturing is based on five principles a) awareness from the customer's point of view about the added value to the products, b) The elimination of all processes which do not add value to the products, c) the continuous flow of the products according to the schedule envisaged for them, d) Production relies on the customer's pull system, e) enhancement to reaching the best by removing all types of waste. LM focuses on eliminating every kind of waste inside the assembly system. The bulk of lean studies determine seven forms of elementary waste: correction, production, motion, material movement, waiting, inventory and process (Godinho Filho et al., 2016).

Additionally, this study concentrates on achieving value in the final product through the intermediate role of process technology, which can boost the product's final results if used appropriately. Furthermore, the competitive advantage is a concept of considerable effects in the business world, which increases improvements in the business environment characterized by rapid changes. Depending on a number of previous studies regarding the problem of the study emerged by showing the effect of lean manufacturing techniques that companies use on competitive priorities in the presence of a very important intermediary factor which is technology as it is an important part of increasing operational efficiency, reducing costs and improving work quality. So, with the up to date market being additional and additional competitive worldwide, producing organizations area unit underneath vast pressure to pursue operational excellence and improves their performance to cut back their prices and supply merchandise of upper quality in shorter lead times (Belekoukias et al., 2014). The results showed that soft manufacturing is very effective in the mass production environment of the garment industries in order to achieve superior results by reducing waste, reducing inventory and reducing defects (Kumar & Kumar, 2015).

2. Literature Review

2.1 Requirements of Lean Manufacturing

Lean manufacturing, or also recognized as lean production, has become one of the most common waste elimination paradigms in the manufacturing and service industries. So, in order to gain efficiency and profitability, many firms have taken advantage of lean manufacturing into their workplaces. Nevertheless, it should be noted that previous work indicates that various sets of methods or strategies have been adapted to some extent by firms according to their own interpretation of lean manufacturing (Wahab et al., 2012). Several labels have been launched for agile manufacturing requirements, some of which tag them Fundamentals, Tools, Requirements, Techniques, or Methods, while others call them elements (Lee, 2003). Therefore, despite the fact that technical aspects are relevant associated drivers for an initial method; innovation exploitation lean tools techniques employed in the given case studies appear to additional simply determine problems and/or facilitate finding them for maintaining method innovations worker engagement is essential (Lopes et al., 2015).

2.1.1 Continuous Improvement (Kaizen)

The Kaizen Concept focuses on improving the work environment, a step-by-step organization for process improvement and waste disposal. The review indicates that the Kaizen application promises waste reduction and improves process efficiency (Lina & Ullah, 2019). According to Venkatesh (2007) Kaizen means good, and continuous improvements do not stop at a particular limit, they are small improvements that execute permanently and include all the staff in the organization. Judeh (2004) indicates that one of the essential approaches to design the continuous improvement process is PDCA, which is developed by Deming to become a general frame for the continuous improvement activities' stages. Essentially, to spread Kaizen culture in the organization, it requires discussion on the significance of some organizational configurations to build and reinforce Kaizen as well as to establish human resources skills that are important for boosting performance and productivity at work (Otsuka et al., 2018).

2.1.2 Total Productive Maintenance

As a result of evolving market dynamics, growing consumer demands from one side and the willingness of consumers to apply new methods of managing processes from the other side, the manufacturing organizations are starting to pursue a competitive advantage. To this end, they start reducing costs, rising job productivity and implementing customer-oriented processes (Gajdzik, 2009). Total Productive Maintenance is one of the lean manufacturing factors to streamline the production cycle and reflect a newly established strategy (Almeanazel, 2010). This recommends that appropriate periodic maintenance practices will eliminate system and equipment failures and preserving low rectification time in case of failure (Sanders et al., 2016).

2.1.3 Cellular Manufacturing

According to Bhat (2008), cellular manufacturing is an approach used to produce diversified goods with as little waste as possible, while the equipment and workstations are organized in a sequential order to allow the movement of materials and components during the manufacturing process preserving minimal delivery time and delay. In this sense, Just-In-Time (JIT) is a management philosophy founded by the Japanese firm Toyota in the 70s of the 20th century and adopted as a production philosophy by DAF Company and other companies as per demand, zero inventory, arrangement and preparation time, and zero defects (Kootanaee et al., 2013; Bozer & Ciemnoczolowski, 2013). In addition, JIT is considered to be an organized system for the improvement of total output, the elimination of waste, cost-effective production planning, and the provision of only the quantity needed for production with the appropriate quality, time, and place. At the same time, providing the minimum quantity of facilities, equipment, materials, and resources based on the balance between the flexibility of the providers and human JIT flexibility. This is applied by adding the necessary components, working teams, employee inclusion, and a philosophical key (Slack et al., 2004).

2.1.4 Rapid Setup / Quick Changeover

Since the lean manufacturing aims at reducing the unnecessary stoppage time for the machine, which resulted either from the arrangement of the machines or the change in the production models, the companies seek continuously to find ways to reduce the arrangement time (Rotaru, 2008; Judah, 2012). Single Minute Exchange of Die (SMED) is considered replacing the die with single arrangement processes. Uni-arrangement is regarded as one of the essential techniques adopted and developed by Shigeo in his book "Revolution in Manufacturing." In essence, the SMED system aims to reduce the machine's arrangement time to less than (10) minutes (Goforth, 2007). Ultimately, in the modern era, It has been a challenge to manufacture several versions with the least amount of changeover time. Advanced manufacturing is moving towards mass customization; therefore, it cannot tolerate long setup times between variants (Sanders, Elangeswaran, Wulfsberg, 2016).

2.1.5 Five-S-Workplace Organizing (5S)

The manufacturing companies cannot function in a messy workplace, or even in a poorly structured and organized workplace, in their endeavour to achieve the discernible benefit of agile production. The ill-arranged workplace would result in increased waste due to unnecessary movement to avoid obstacles as well as wasting time looking for equipment, materials, and others. For instance, the randomly assembled workplace would result in output delays due to faults, as well as maintenance interruptions due to regular unexpected accidents. 5S which stand for Sorting, Set in order, Shining, Standardizing and Sustaining is considered as basic requirements for lean manufacturing. They are defined as a systematic approach to organize and managing the workplace or the workflow to improve efficacy and reducing waste (Buggy & Nelson, 2005). Pfeifer (2005) explained that 5S are five Japanese words means (organization, maintenance, discipline, arrangement, and cleaning). In this perspective, Venkatsen (2007) identified them as an organized process to manage the properties, securing the equipment and services to achieve a quiet environment at the work's sight. In addition, the 5S is a tool that allows eliminating wasted time searching for its tools, to improve safety and efficiency, to reduce the latest malfunctions, to release space for useless work (Azzemou & Noureddine, 2018). This tool, as all alternative Lean producing tools, relies on continuous improvement and so it's very important to stay up the producing parameters to push the philosophy (Velarde et al., 2009).

2.2 Importance of Competitive Advantage and Competitive Advantage priority

Competitive advantage is the optimal exploitation of resources and capabilities by cost and differentiation strategy to achieve a competitive edge. The competitive advantage is the subject that significantly concerns the organizations, and this because the managers invest most of their time in serious thinking on this subject because it plays an essential role in deciding their organizations' future. Under the austerity conditions of the past decade, organizations started to think and collaborate with research institutions to find the secrets of processing competitive advantage and looking for its sustainability, such as attaining the origin of scarce resources or achieving new methods of organization management and manufacturing products at a reduced cost. Collier (2007) illustrated the firm could reduce the costs through the effective usage of the available production capacity in addition to the continuous improvement in the product's quality and innovation in product design & process technology. As such, this is deemed as essential fundaments to reduce the costs, and also helping managers in supporting the firm's strategy in the cost domain. Al-Azzawi (2000) claimed that operations management aims to reduce the cost of production relative to rivals and to obtain better prices to improve the competitive advantage of the products. Heizer and Render (2001) stated that in order to achieve the expected value of the company that is important to its purpose, it is necessary to evaluate the expectations and desires of the customers regarding the quality and the effort to achieve it. Slack et al. (2004) state that quality is perceived as one of the competitiveness's core attributes, suggesting that value is an ideal way to deliver goods according to the needs of customers.

Krajewski and Ritzman (2005) suggested that consumers are interested in obtaining quality goods that meet their specified requirements, which are the specifications they perceive or see in the ads. Presumably, businesses that do not offer quality goods that meet the needs, requirements, and aspirations of the consumer cannot survive and thrive in the market. The main purpose of the LM is to improve resource use and space more effectively in order to increase the return from its existing resources. Waste free manufacturing is applied to improve efficiency by eliminating waste and non-value added activities from the manufacturing system (Kumar& Kumar, 2015). Along the same line, Slack et al., (2004) explain that when we want to perform the work quickly, this means reducing the time between receiving the customers' orders for the products and delivering those products to the end-users: Delivery speed- This speed is measured by the exploited time between receiving the customers' demand and satisfying this demand, which is called the waiting time. It is possible to increase the supplying speed by reducing the waiting time. Just in-Time – Delivery: It means delivering the customers' orders at the determined time for them. Development speed: It is the speed at which new ideas are introduced and the speed of production, which is expressed by the time between the idea generation and the final product design and introduction to the market. Accordingly, Price or quality is most significant for some customers, corporations that serve such customers would possibly comply with perform less on different performance measures Knol et al. (2018). Made implementation of lean principles goes abundant on the far side inventory reduction and frequent deliveries. in view of the fact that LM unit focuses on eliminating waste, rising quality, reducing prices, and shortening delivery (Meybodi, 2017).

2.3. Technological process

Technology is one of the fundamental ingredients that lead to successful manufacturing transformation. Therefore, many companies, governments, and academic institutions now widely recognize the critical role that technology plays as a differentiation tool to distinguish themselves in today's world markets. Porter (1998) discerned the crucial role that technology plays as a competitive enabler in all sectors of the economy around the world; he stated: "technology has the potential to change the structure of the industry and create new industries." Consequently, the incorporation of technology into production lines is an imperative move. In this line, Seino (2007) emphasized the importance of this integration, which raises a significant challenge for managers and decision-makers across many industrial organizations. He advocates the need for a new functional structure to establish a competitive edge for manufacturing industries through the successful integration of manufacturing technology and product design processes. In general, Gregory (1995) suggested that technology management be made up of five general processes which include :(a) Identification of technologies that are (or maybe) of business interest. (b) Set of technologies which the company will endorse. (c) Specific technology acquisition and assimilation; (d) Taking advantage of technology to make profits or other gains. (e) Preservation of information and know-how ingrained in products and production systems. Calp and Doğan (2015) postulated that if the organizations generating products, services and knowledge are unable to adapt to these trends and make rational decisions and enforce them at the right place and time, they may encounter several troubles and even collapse. Fortunately, the efforts of the scholars are geared to resolve the problems of integration. Thus, a vast array of methods and frameworks that have been put in place to help managers and decision-makers grasp the practical and conceptual issues of technology management (Atem & Yella, 2007; Cetindamar, 2010; Basu et al., 2018).

In essence, information technology (IT) can be described as a combination of hardware and software infrastructure capable of capturing, storing, transmitting, and using business information to enhance communications, decision making, and eliminating unnecessary activities (Reynolds 2010). In this regard, many businesses have high expectations of investing in IT for future business benefits, expectations that could enable the organization to cut costs, streamline processes, improve performance, optimize workflow and communications, sustain repeatable service levels, improve risk management mechanisms, develop new business strategies, promote creative and acquisition-driven growth, and gain competitiveness (Beveridge, 2002). Investing in IT needs high expenditure; thus, top management should make the right decision to achieve a trade-off between substantial investment and expected benefits. However, IT investment is an unavoidable practice by organizations as any improvement in rules, procedures, and strategy followed by investment in new hardware, software, and other IT infrastructure (Issa-Salwe et al., 2010). Moreover, relevant for a large number of companies aiming to transform their operations using the emerging ICT solutions Buer et al. (2018).

3. Framework and Research Hypotheses

3.1 Research Model

Based on the literature review, the researcher proposes a model to measure the impact of lean manufacturing technique on competitive priority. To find more accurate analysis between lean manufacturing technique and competitive priority, the purpose of technological process is mediated as important section in lean production as facilities to get the flexibility and quickly in production. The proposed study of this paper is presented in Fig. 1.

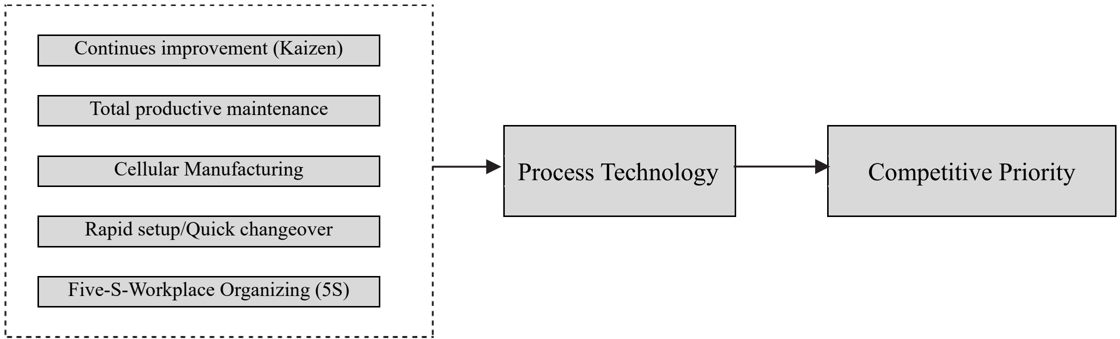

Fig. 1. The Research Model

3.2 Research Hypothesis.

H_{01}: There is no impact of Manufacturing Techniques on Competitive Priority (at 0.05 level).

H_{02}: There is no impact of Manufacturing Techniques on process technology (at 0.05 level).

H_{03}: There is no impact of process technology on competitive priorities (at 0.05 level).

H_{04}: Process technology has no mediation effect at 0.05 level on the relationship between Manufacturing Techniques and competitive priorities.

4. Research Methodology

The study methodology in this study is descriptive by describing the phenomena. To test the proposed theoretical model (PLS) program is used. This type of analysis enables the formation of modeling based on both apparent and underlying variables, which is an important characteristic of well-assumed model, since most formulations represent an unnoticeable abstraction rather than experimental and concrete phenomena. Moreover, in modeling the structural equation, measurement errors, multi-group comparisons and variables with multiple indicators are taken into account. This type of Analysis enables modeling to be modeled based on both apparent and latent variables.

4.1 The Population and Sample of the. Research

The study population consisted of all Jordanian companies clothing companies listed on the Amman stock exchange in Jordan, The sampling element and analysis included all executives and directors of departments, sections and employee specialized in clothing companies. To select the sample of the study, the researcher employed a simple random sample and 170 members were targeted and 156 properly filled questionnaires were received. In our survey, about 58.3 percent of the participants were male and the remaining 41.7 percent were female.

Validity and reliability

The validity analysis entitles the convergent validity represented by the standardized items loadings and the discriminate validity which expressed by the inter correlation matrix among the variables. The AVE was also estimated to indicate the percentage of the explained variance per the items in each factor. The inter correlations compared to the square root of the (AVE) such that if the value of the square root of AVE for a factor was greater than the inter correlations of that factor, it expresses good discriminate validity. The reliability was assessed in two different approaches (CA) Cronbach alpha and the composite reliability (CR). The results concerning the independent variable, the dependent variable and the mediator variable are presented Table 1. The results present the values of items standardized loadings. The standardized loading is considered to reflect good validity if it is (≥ 0.50). Inspecting the results provided can be visualized that two loading values suggested by the mediator variable (0.479) for the item coded (MV.2) and (0.493) for the item coded (MV.6) did not meet the desired minimal loading accordingly they were excluded and deleted. After then the minimum loading being observed was assigned to the item coded (MV.2) in the Process technology factor which was (0.567) for the item coded (MV.1) so this value was above the minimum required (0.50) suggesting reasonable convergent validity for each factor. As a result, the convergent validity is considered satisfied

The table presents the values of an important indicator for the factors validity (AVE) which represents the amount of variance shared by the items a factor, this indicator values must be ≥50.0 as a good indication of the factor validity. Inspecting the values, the observed minimum value was (50.0) for Process technology. So, the results tell that the discriminate validity of the factors has been satisfied. The results also show the Cronbach alpha composite and reliabilities. Inspecting the provided values (CA) the minimum value obtained was (0.685) for Rapid setup items sub factor, while the minimum value obtained using the (CR) was (0.768) for Continuous improvement items sub factor. The reliability mentioned values reflect a high level of reliability values (> 0.70).

Table 1
Convergent validity and reliability analysis results Composite (CR) and Cronbach Alpha (CA) using Confirmatory Factor Analysis (CFA)

Factor	Code	Factor loadings	CA	CR	AVE
Continuous improvement	IV 1.1	0.727	0.801	.0768	55.8
	IV 1.2	0.811			
	IV 1.3	0.791			
	IV 1.4	0.651			
Total production maintenance	IV 2.1	0.685	0.709	0.821	53.5
	IV 2.3	0.823			
	IV 3.1	0.716			
	IV 2.4	0.694			
Cellular manufacturing	IV 3.1	0.811	0.804	0.872	63.1
	IV 3.2	0.855			
	IV 3.3	0.835			
	IV 3.4	0.664			
Rapid setup	IV 4.1	0.696	0.685	0.809	51.5
	IV 4.2	0.649			
	IV 4.3	0.807			
	IV 4.4	0.711			
Five-s-workplace organizing	IV 5.1	0.717	0.830	0.888	66.7
	IV 5.2	0.865			
	IV 5.3	0.895			
	IV 5.4	0.777			
Process technology (mediator MV)	MV.1	0.567	0.798	0.855	50.0
	MV.2	0.479*			
	MV.3	0.621			
	MV.4	0.691			
	MV.5	0.769			
	MV.6	0.493**			
	MV.7	0.735			
	MV.8	0.827			
Competitive priority	DV.1	0.790	0.888	0.910	56.2
	DV.2	0.829			
	DV.3	0.847			
	DV.4	0.763			
	DV.5	0.601			
	DV.6	0.670			
	DV.7	0.755			
	DV.8	0.708			

(*deleted first run, ** deleted second run)

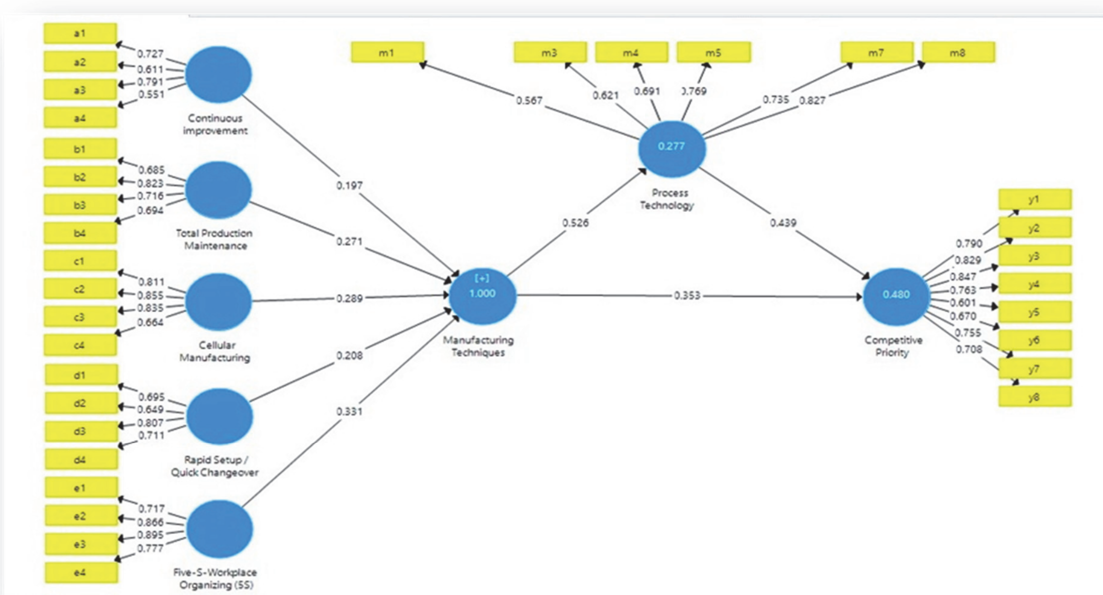

Fig. 2. Model of Standerdized Loading and Path Coeffecients For Thetrimmed Modle

Table 2
The results of correlation among different variables

Factors	Cellular Manufacturing	Competitive Priority	Continuous improvement	Five-S	Manufacturing Techniques	Process Technology	Rapid Setup	Total production
Cellular Manufacturing	**0.795**							
Competitive Priority	0.431	**0.749**						
Continuous improvement	0.500	0.448	**0.677**					
5- S Workplace Organizing	0.517	0.434	0.452	**0.817**				
Manufacturing Techniques	0.606	0.584	0.416	0.803	**0.575**			
Process Technology	0.338	0.624	0.328	0.529	0.526	**0.707**		
Rapid Setup	0.506	0.360	0.453	0.475	0.522	0.285	**0.718**	
Total Production Maintenance	0.521	0.543	0.479	0.495	0.572	0.453	0.444	**0.721**

Table 2 indicates the discriminant validity results. This type of validity assumes that the variable correlates with reasonable degree. The results indicated that the greatest inter correlation value was detected between Five-S and Manufacturing Techniques which was the mediator variable (0.803). This correlation value may be justified as the 5 -s is one of the components (factors) that compose the independent variable (Manufacturing Techniques). Another important measure for discriminant validity is the square root of the (AVE) presented in bold diagonally. This indicator assumes that its value will be greater than the other inter correlations with the other variables. Clearly the values tell that the discriminate validity has been satisfied.

Table 3
Mean, standard deviations and relative importance index RI

No.	Factors	Mean	Std. Dev.	RI %	Level
1	Continuous improvement	4.11	0.52	82.2	High
2	Total Production Maintenance	4.22	0.56	84.4	High
3	Cellular Manufacturing	3.90	0.66	78.0	High
4	Rapid Setup / Quick Changeover	3.75	0.58	75.0	High
5	Five-S-Workplace Organizing (5S)	3.83	0.60	76.6	High
6	Manufacturing Techniques (independent)	3.96	0.44	79.2	High
7	Process Technology (mediator)	3.85	0.59	77.0	High
8	Competitive Priority (dependent)	4.04	0.60	80.8	High

Means description (1 – 2.33 low, 2.34 – 3.67 moderate, 3.68 – 5 high)

Table 3 presents the values of mean and standard deviation and relative importance index RI for the study variables. The results tell that all the variables were "high" according to the sample's opinions. Concerning the sub factors of the independent variable (Manufacturing Techniques) it was noticed that Total Production Maintenance was the highest sub factor being rated (4.22) and that the (Rapid Setup / Quick Changeover) was minimal sub factor that has been rated (3.75). The Competitive Priority was rated by a mean of (4.04) and the that the mediator variable (Process Technology) was assessed by the sample by a mean of (3.85).

Hypotheses testing

Table 4
Standardized total effects

hypotheses	**impact direction**	**β**	**prob**
H01	Manufacturing techniques on competitive priority	0.584	0.000
H02	Manufacturing techniques on process technology	0.526	0.000
H03	Process technology on competitive priority	0.439	0.000

1- Results of testing the first main hypothesis:

H_{01}: There is no impact of Manufacturing Techniques on Competitive Priority (at 0.05 level).

According to the results provided by Table 4 the impact value of Manufacturing techniques on competitive priority was expressed by the standardized beta coefficient it was found to be (0.584) and this impact value was considered to be statistically significant as the related probability value (0.000) was < 0.05

Consequently, the null hypothesis represented by the main one is rejected concluding that Manufacturing Techniques affects Competitive Priority.

2- Results of testing the second main hypothesis:

H_{02}: There is no impact of Manufacturing Techniques on process technology (at 0.05 level).

The results provided by Table 4 reflects that the impact value Manufacturing Techniques was expressed by the standardized beta coefficient (0.526) and the impact value was considered to be statistically significant as the related probability value (0.000) was < 0.05

Consequently, the null hypothesis is rejected concluding that Manufacturing Techniques affects process technology.

3- Results of testing the third main hypothesis:

H_{03}: There is no impact of process technology on competitive priorities (at 0.05 level).

The results provided by Table 5 reflects that the impact value process technology was expressed by the standardized beta coefficient (0.439) and this impact value was considered to be statistically significant as the related probability value (0.000) was < 0.05 Consequently, the null hypothesis is rejected concluding that process technology affects competitive priorities.

4- Results of testing the fourth main hypothesis:

H_{04}: process technology has no mediation effect at 0.05 level on the relationship between Manufacturing Techniques and competitive priorities.

The mediation effect of this hypothesis was tested using the smart PLS software program (version3.2.9). the results are included in the Table 5.

Table 5

Standardized direct, indirect and total effects for the models mediated relations

Relation direction			Direct Effects		Indirect Effects			Total effect
			B	prob	value	prob	VAF (%)	
Manufacturing Techniques	→	(process technology)	0.526	0.000	0.231	0.000	39.55	0.584
process technology	→	competitive priorities	0.439	0.000				
Manufacturing Techniques	→	competitive priorities	0.353	0.000	-	-		

(VAF < 20 no mediation, between 20 to < 80 partial mediations and 80 + full mediation

The results included in Table 5 have indicated that the magnitude of indirect effect of process technology on the relationship between Manufacturing Techniques and competitive priorities was estimated by (0.231) which was considered to be statistically significant as the probability value (0.000) was (< 0.05).

The results show that the direct impact value of the Manufacturing Techniques variable on the competitive priorities (dependent) variable (in the presence of mediator) was (0.353) as a result the total effect will be the sum of both mentioned values (0.584). The mediation effect was considered to be partially affecting the relationship between the independent and dependent variables since the significance of the relationship was the same with and without the presence of the mediator.

The VAF (variance accounted for) value (39.55 %) which reflects the percentage of the indirect effect to the total effect indicate (numerically) that the mediation was considered to be partially too. Once the impact signs of the two paths of mediator were the same (positive); the effect is called partial.

Consequently, the null hypothesis is rejected concluding that process technology mediates the relationship between Manufacturing Techniques and competitive priorities at 0.05.

The original (complete) model. Standardized loading and path coefficients for the trimmed model Significance using t test results for the coefficients are presented in Fig. 3 as follows,

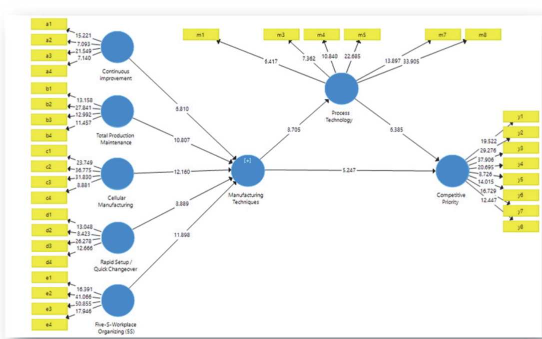

Fig. 3. The results of Standardized Loading and Path Coefficients for the Trimmed Model Significance Using T Test Results for the Coefficients

5. Conclusion

Based on literature review the Lean manufacturing is a philosophy, which aims to eliminate waste constantly, in all processes, through small and gradual improvement. It improves quality and reduces imperfections, as well as enhances the overall manufacturing flexibility. However, sometimes, it faces some limitations such as low productivity, long cycle time, and costly organization. The following reflects the Statistical results from practical implication from clothing companies.

1. The null hypothesis represented by the main one is rejected concluding that Manufacturing Techniques affects Competitive Priority.
2. The null hypothesis is rejected concluding that Manufacturing Techniques affects process technology.
3. The null hypothesis is rejected concluding that process technology impact on competitive priority.
4. Results of testing the fourth main hypothesis about mediation:

- The indirect effect of process technology on the relationship between Manufacturing Techniques and competitive priorities was estimated by (0.231) which was considered to be statistically significant when the level of significance is 5%.
- The results show that the direct impact value of the Manufacturing Techniques variable on the competitive priorities (dependent) variable (in the presence of mediator) was (0.353) as a result the total effect will be the sum of both mentioned values (0.584).
- VAF value (39.55 %) which reflects the percentage of the indirect effect to the total effect indicate (numerically). Once the impact signs of the two paths of mediator were the same (positive); the effect is called complementary partial so the null hypothesis is rejected concluding which means process technology mediates the relationship between Manufacturing Techniques and competitive priorities at 0.05.

6. Recommendation

1. Encouraging the organizations under discussion on the requirement of spreading the philosophy of eliminating waste of all types among the operating people, and all levels, finding out the causes, analyzing the reasons, resulting in eliminating waste to realize outputs of nice worth and nil waste within the organizations in Jordanian companies.

2. Urging the organizations to review the experiences of successful firms that have succeeded in applying lean manufacturing in industry sector to require advantage of the results of experiments to require the results and adapt them to a way acceptable to the Jordanian producing surroundings to enhance the national economic in Jordan.

4. Enhancing the applying of a technological platform for organizing the work surroundings during a comprehensive manner throughout the organization owing to its role in achieving the arrangement and organization of labor sites and achieving streamlining within the work.

References

Azzemou, R & Noureddine, M. (2018). Continuous improvement for the firm's competitiveness: implementation of new management model. *Management Science Letters, 8*(1), 19-32

Almeanazel, O. T. R. (2010). Total productive maintenance review and overall equipment effectiveness measurement. *Jordan Journal of Mechanical and Industrial Engineering*, *4*(4).

Atem, T., & Yella, G. (2007). *Continuous Quality improvement: Implementation and Sustainability*.

Basu, P., Ghosh, I., & Dan, P. (2018). Using structural equation modelling to integrate human resources with internal practices for lean manufacturing implementation. *Management Science Letters*, *8*(1), 51-68.

Belekoukias, I., Garza-Reyes, J. A., & Kumar, V. (2014). The impact of lean methods and tools on the operational performance of manufacturing organisations. *International Journal of Production Research*, *52*(18), 5346-5366.

Beveridge, C. (2002). Guidelines for Aligning IT with Business Strategy.

Bhat, S. (2008). Cellular manufacturing: The heart of lean manufacturing. *Advances in Production Engineering & Management*, *3*(4), 171-180.

Bozer, Y., & Ciemnoczolowski, D. (2013). Performance evaluation of small-batch container delivery systems used in lean manufacturing – Part 1: system stability and distribution of container starts. *International Journal of Production Research*, *51*(2), 555–567.

Buggy, J. M., & Nelson, J. (2005). Applying lean production in healthcare facilities. *Informedesign*, *6*, 1-5.

Buer, S.-V., Strandhagen, J. O., & Chan, F. T. S. (2018). The link between Industry 4.0 and lean manufacturing: mapping current research and establishing a research agenda. *International Journal of Production Research*, *56*(8), 2924–2940.

CALP, M. H., & DOĞAN, A. Technology Management Process and Encountered Problems in Organizations. *organization*, *8*, 13.

Cengiz, E. (2012). *Lean Way Of Valuing Inventory*. 3rd ed.

Cetindamar, D. (2010). Technology Management Activities and Tools. Faculty of Management, Sabanci University, Turkey.

Chase, R & Aquilano, N & Jacobs, F. (2001). *Operations Management for Competitive Advantage*. Mc Graw- Hill Companies.

Collier, E. (2007). Operation Management an Integrated Goods and services, Approach, Thomson, South, western, USA international, student edition.

Daniels, J. D., Radebaugh, L. H., & Sullivan, D. P. (2015). *International business environments and operations*. Pearson Education Limited.

Gajdzik, B. (2009). Introduction of total productive maintenance in steelworks plants. *Metalurgija, 48*(2), 137- 140.
Goforth, K. (2007). Adapting lean Manufacturing Principles To The Textile Industry: http://www.lib.ncsu.edu/theses/available/etd-03212007-230809/unrestricted/etd.pdf.
Godinho Filho, M., Ganga, G. M. D., & Gunasekaran, A. (2016). Lean manufacturing in Brazilian small and medium enterprises: implementation and effect on performance. *International Journal of Production Research*, *54*(24), 7523–7545.
Gregory, M. (1995). Technology management a process approach. *Proceedings of the Institution of Mechanical Engineers 209*, 347–35.
Hallgren, M., & Olhager, J. (2009). Lean and agile manufacturing: external and internal drivers and performance outcomes. *International Journal of Operations & Production Management*.
Heizer, J., & Render, B. (2001). *Principles of Operations Management*. 3rd ed, Prentice Hall, USA.
Issa-Salwe, A., Ahmed, M., Aloufi, K., & Kabir, M. (2010). Strategic information systems alignment: alignment of IS/IT with business strategy. *Journal of Information Processing Systems*, *6*(1), 121-128.
Johansson, P. E., & Osterman, C. (2017). Conceptions and operational use of value and waste in lean manufacturing – an interpretivist approach. *International Journal of Production Research*, *55*(23), 6903–6915.
Judah, M. (2012). *Total Quality Management*: Concepts and Applications (6th ed.). Amman, Jordan: Dar Wael for Publication and Distribution.
Kootanaee, A., & Babu, K., & Talari, H. (2013) Just-in-time manufacturing system: From introduction to implement. *International Journal of Economics, Business and Finance, 1*(2).
Knol, W. H., Slomp, J., Schouteten, R. L. J., & Lauche, K. (2018). Implementing lean practices in manufacturing SMEs: testing 'critical success factors' using Necessary Condition Analysis. *International Journal of Production Research*, *56*(11), 3955–3973.
Krajewski, L., & Ritzman, L.P. (2005). *Operations Management*. 7th ed., Prentice Hall:New Jersey.
Kumar, R., & Kumar, V. (2015). Lean manufacturing in Indian context: A survey. *Management Science Letters*, *5*(4), 321-330.
Kumar, R & Kumar, V. (2016). Evaluation and benchmarking of lean manufacturing system environment: A graph theoretic approach. *Uncertain Supply Chain Management*, *4*(2), 147-160.
Kumar, R., & Kumar, V. (2016). Analysis of significant lean manufacturing elements through application of interpretive structural modeling approach in Indian industry. *Uncertain Supply Chain Management*, *4*(1), 83-92.
Lee, Q. (2003). Implementing Lean Manufacturing Imitation to Innovation. www.strategosinc.com.
Lina, L., & Ullah, H. (2019). Global Journal of Management and Business Research. *Global Journal of Management and Business Research: A Administration and Management*, *19*(1), 0975-5853.
Lopes, R. B., Freitas, F., & Sousa, I. (2015). Application of lean manufacturing tools in the food and beverage industries. *Journal of Technology Management & Innovation*, *10*(3), 120–130.
Meybodi, M. Z. (2017). Sequential and integrated new product development: Experience transferred from conventional and lean manufacturing systems. *Journal of Competitiveness Studies*, *25*(1), 7–22.
Omoush, M. M. (2020). Investigation the Relationship Between Supply Chain Management Activities and Operational Performance: Testing the Mediating Role of Strategic Agility-A Practical Study on the Pharmaceutical Companies. *International Business Research*, *13*(2), 1-74.
Otsuka, K., Jin, K., & Sonobe, T. (2018). *Applying The Kaizen In Africa, Switzerland*. Palgrave Macmillan, 57-60
Pfeifer, M. (2005). The 5S Workplace: A System For Visual Control and Lean production. *NASFM Magazine*.
Porter, M. (1998). *Competitive Advantage: Creating and Sustaining Superior Performance*. Free Press, New York, USA.
Pyzdek, T. (2000). *Six Sigma and Lean Production Which process improvement approach is right for you and your need*?
Reynolds, W. (2010). *Information technology for managers.* University of Cincinnati, p4-5
Rotaru, A. (2008). Implementing Lean Manufacturing: http://www.tcm.ugal.ro/Anale/2008/L21_LAUDJG_2008_AR.pdf
Sanders, A., Elangeswaran, C., & Wulfsberg, J. P. (2016). Industry 4.0 implies lean manufacturing: Research activities in industry 4.0 function as enablers for lean manufacturing. *Journal of Industrial Engineering and Management (JIEM)*, *9*(3), 811-833.
Schroeder, R. G. (2000). *Operations management: contemporary concepts*. Irwin/McGraw-Hill.
Seino, T. (2007). *Practical Framework of Manufacturing Technology Management for Efficient Cooperation between Design and Manufacturing Sections*. Toshiba Corp., Tokyo, Japan.
Slack, N., Chambers, S., & Johnston, R. (2010). *Operations management*. Pearson education.
Stevenson, J. (2010). *Operation management an Asian prospection.* 10th ed., Boston Chnory.
Tinoco, J. (2006). Implementation of lean manufacturing. Dissertation Submitted in Partial Fulfilment of The Requirements for The Degree Master in Science Degree in Management Technology, University of Wisconsin-Stout
Venkatesh, J. (2007). An introduction to total productive maintenance (TPM). *The plant maintenance resource center*, 3-20.
Velarde, G. J., Saloni, D. E., van Dyk, H., & Giunta, M. (2009). Process flow improvement proposal using lean manufacturing philosophy and simulation techniques on a modular home manufacturer. *Lean Construction Journal*, 77-93.
Wahab, A. N. A., Mukhtar, M., & Sulaiman, R. (2013). A conceptual model of lean manufacturing dimensions. *Procedia Technology*, *11*(0), 1292-1298.

Appendix 1. Questionnaire

The items	Strongly agree	Agree	Neutral	Disagree	Strongly Disagree
Continuous improvement					
The firm's management supports the continuous improvement programs.					
The firm's management works for forming teams work to follow-up the continuous improvement process and determining their responsibility.					
The firm's management has the readiness to remove the obstacles and the barriers that might face the continuous improvement process.					
The firm's management believes that the absence of errors does not mean there is no need for the continuous improvement process.					
Total Production Maintenance					
The firm works for applying the comprehensive production maintenance system for the machines and the equipment.					
There is a precautionary and predictive maintenance system in the firm.					
The firm concerns about the offered suggestions and ideas from the employees at the maintenance division to develop the work in the division.					
The employees confirm the instruments and the equipment safety after the end of their usage.					
Cellular Manufacturing					
Cellular manufacturing application helps in reducing the stock of the semi-manufactured materials.					
The firm's management uses the internal arrangement which achieves the material smooth flow without waiting time or interference between the production processes.					
The firm works for applying the cellular manufacturing inside the different production divisions.					
Firm's management focuses on the rapid design and modification possibility on the production lines according to the operative requirements.					
Rapid Setup / Quick Changeover:					
The un-necessary machines stoppages resulting from preparing the machines are considered few.					
The company cares about reducing the preparation and arrangement time at the lowest possible level.					
The company works for facilitating the procedures reducing the preparation time to reduce waiting time.					
The firm works for the appropriate preparation and arrangement of the equipment to reduce the defects in the products to reach high quality level.					
Five-S-Workplace Organizing(5S):					
The Firm's management asserts the necessity for organizing everything in all of the factory's divisions and at all production stages.					
The firm's management cares about arranging the workplace and storing the materials at their designated places.					
The firm's management asserts always the workplace cleanliness to provide healthy work environment and nobility for all.					
The firm undertakes precautionary maintenance as a fixed method and continuously.					
Process Technology (mediation)					
The firm designs the production processes to manufacture high quality products.					
The management processes the scientific skill and the required experience to update and develop the processes technology.					
The relate divisions cooperate between each other to reach the best design for the processes technology.					
The firm works for the process technology relevance with the type of the production system and the adopted manufacturing strategy.					
The firms work to achieve integrated case between process technology and the products design stages.					
The firm selects the appropriate process technology methods in light of the process costs.					

The engineers and the technicians have scientific knowledge about the bases and stages of the production process technology.
The firm depends on the good usage of the scientific process technology in increasing its productivity effectiveness and competence.
Competitive Priority (independent)
The factory's products are considered less costly compared to products of other factories.
The firm is characterized by reducing the managerial and operational costs and other work costs.
Performance evaluation method used at the factory leads to reducing time waste.
The firm's services are characterized by high quality.
Our firm works for making its products specifications comply with the national standards specifications.
The firm always works for setting employees training programs for the purpose to improve the quality of the products offered to the customer.
The firm processes high flexibility in responding to the taking place changes in the customers need and desires .
Out firm's machines and equipment are characterized by being multi-purposes.
Our company is continuously committed to the determined dates when delivering the products to the customers.