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Lean Six Sigma effect on the Quality of the Products in Jordanian Food Companies: The Moderating Role of the Manufacturing Process

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ABSTRACT

The purpose of this study is to determine the effect of lean six sigma and the quality of the product and manufacturing process. Further, its focus on understanding the impact on the defect, over production, Motion, Waiting time, through the role of Manufacturing Process on quality of products. The study applied the questionnaire, which was adapted from past literature. The questionnaire was distributed to a sample of 180 respondents, and the number of returned items was 142. The study applied a purposive sample that (employee) hold positions related to quality management, production, research and development (R&D) at Jordanian food industry. The data analysis was performed using Statistical procedures being used several methods were used, including the exploratory analysis, the global empirical analysis, the Cronbach alpha analysis, Impact coefficients (beta), and the arithmetic mean, standard deviation, multiple regression, to test moderating hypothesis the Process macro analyses. Accordingly, and based on a multiple regression analysis, the alternative hypothesis is adopted, concluding that the elements of lean six sigma influence the consistency of the goods excluding the variables of motion and waiting time from the respondent's point of view. As a consequence of the manufacturing process, the relationship between the lean six sigma variable and the quality of the product has a positive moderation effect.

Keywords: Lean Six Sigma, Waiting Time, Manufacturing Process, Quality of Products, Jordanian Food Companies
JEL Classification: M11

1. INTRODUCTION

The rapid technological growth in recent years and the emergence of several issues such as globalisation, shifts in economic structures, diverse needs and preferences of consumers or customers, increasing the intensity of competition between companies and organisations put tremendous pressure on food and other manufacturing companies (Alkunsol et al., 2019; Dora et al., 2014). All these factors have led to finding alternative ways to help these institutions for the development and continuity, finding different methods and instruments help in preserving the quality of the products and developing them (Dora and Gellynck, 2015).

At present, quality is considered one of the most critical measures through which the company can survive quality has been significantly spread worldwide, especially in the commercial field. An inferior product quality might be produced because of the difficulties and barriers facing the production process (Kosina, 2013; Usman and Hutasoit, 2019). As such, for the company to be able to avoid the mistakes and the violations that might occur during the production process, there is a need to monitor quality to reduce the losses (Hernadewita et al., 2019). Thus they began to improve the quality of the product, starting from quality inspection to quality assurance and total quality management (TQM), all established by Japanese companies (Alkunsol et al., 2019). Among them, lean Six Sigma is a renowned quality control methodology for improving performance, which is proved to be efficient for hundreds of businesses around the world (Maheshwar, 2012). From a business viewpoint, the Six Sigma approach is robust and enhances process performance and decreases product defects dramatically (Sánchez-Rebull et al., 2020).

Lean Six Sigma methodology creates an opportunity to improve the products, satisfying the customers' needs and requirements and increasing profits and directs the management to treat the defect reducing defects ratio (Dora et al., 2014; Usman and Hutasoit, 2019). Many studies such as Alkunsol et al. (2019) and Hernadewita et al. (2019) suggested that there were problems with some of the production process, so lean Six Sigma methodology emerged as a way to reduce the possibility of the waste and production process issues. Essentially, Lean Six Sigma focuses on the assumption that any device or process does not add value to the quality of the product or can avoid consumers. The fundamental goal is to reduce defects and errors in the manufacturing process. For example, some problems involve overproduction by producing excessive materials, endure the costs of waste goods, waiting times, excessive traffic and motion bottlenecks(Alkunsol et al., 2019).For instances, seven wastes were identified by Stoiljković et al. (2011) Process consists of the following: manufacturing without value added, inventory, overproduction, waiting time, defects, movement, and transport. Equally, Arunagiri and Babu (2013) pointed to several sorts of waste such as defects, wasted movement, unemployed talent, excess stock handling and intensity, transportation, slow down, waiting time and overproduction.

Researchers in their studies have confirmed the significant role that lean Six Sigma plays in reducing these problems through the continuous improvement (Kosina, 2013) and preserving the quality standards to get rid of the defects through settling specific and rational plans (Albliwi et al., 2015). Research shows that lean tools and methods have assisted production companies in enhancing their processes and operations (Albliwi et al., 2015; Alkunsol et al., 2019). However, the real impact of these methods and tools on new operational performance measures, i.e. cost, speed, reliability, quality, and flexibility, is still questionable (Belekoukias et al., 2014).

Regardless of the source of the problem that belongs to an inefficient process or waste issue the real impact of applying lean Six Sigma elements on manufacturing process towards achieving highest quality products that satisfy the customers is required. Hence, in this study, the four elements overproduction, motion, defect, waiting time were investigated to show the real effect of applying lean Six Sigma method to achieve high-quality products through improving the production process. Additionally, if these wastes affect production, there is a possibility of an overlapping impact on the quality of the product. This paper tries to rank these four elements based on their degree of impact on the Jordanian food industry. The main problem of this study is the need to focus on the waste and defects based on implementing the Lean Six Sigma practices upon investigating the moderating role of the manufacturing process. Further, the suggested ideas intend to reduce the unmatched products and standards, also to improve the overall corrective actions and plans. Accordingly, this will lead to improving the quality of the products.

2. LİTERATURE REVİEW

2.1. Concept of Lean Six Sigma

Six Sigma is a term which Motorola developed in the 1980s (Tennant, 2001). .Lean Six Sigma is considered one of the most critical administrative methods since it is based on understanding the facts and data, concerning the management accurately and increasing productivity (Antony, 2006). Christopher and Lee (2004) indicate that lean Six Sigma is an administrative philosophy based on focusing on eliminating of the defects through improving the production process depending on knowledge, facts, data and the analysis to improve quality and achieving the required goals.

While Larry (2002) identified it as a comprehensive and flexible system helps in controlling the products, improving them through finding out the defects and attempt to remove them to reach quality at minimum cost and the shortest time. In essence, Lean Six Sigma consists of six degrees (from 1 to 6), number (6) is the highest in the quality levels, the increasing quality degree of a product the less the defects and the errors in it. Suresh defined it as a method to apply it in the companies and the institutions to direct them, preserving their development and enhancing them. From a production perspective, the early definition of Goldsby and Martichenko (2005) stated that it as an administrative method helps in solving the problems and eliminating the negative influence in the production process. Regardless of the definition adopted, lean Six Sigma methodology could improve the product development process and process design, shortening product lead times by decreasing the total production process cycle time. The root causes of the problem could be detected using Six Sigma to reduce variation in processes to prevent defects. In fact, Six Sigma methods offer guidance which might help employees comprehend how to do the job and educate them to rectify possible problems (Tjahjono et al., 2010).

2.2. Principles of Lean Six Sigma

Lean Six Sigma philosophy is based on a broad and comprehensive concept, indicates that lean Six Sigma philosophy is a strategy guarantees the rapid and continuous development for the company (Prieto-Avalos et al., 2014). It is based on a number of basic principles which are the focus on the client's needs and requirements, this includes the whole society, making the decision based on clear and accurate data, and the continuous improvement, cooperating and participation, setting effective method to solve the problems and the effective administration(Smętkowska and Mrugalska, 2018).Lean and Six Sigma have principles for addressing quality and operational activities management issues as shortly as they are pinpointed (Chugani et al., 2017).This lean Six Sigma could be executed or implemented in any industrial sector by continuously improving company operations and satisfying customer/stakeholder (Albliwi et al., 2015).

2.3. Stages of Implementing Lean Six Sigma

Six Sigma DMAIC stages, the most widely used concept in improving the quality of a product or service. According to DMAIC, to execute lean Six Sigma, it should pass through a number of stages, the first stage concerns the (Definition) stage, in this stage the company try to describing the problem, determining the clients' requirements, quality cost, responsibilities, work stages and the desired goals to be achieved (Gupta and Wiggenhorn, 2004; Stamatis, 2001).

The second stage is the (Measure), through which evaluating the present situation, and searching for the basic problem (Eckes, 2002) also determining the processes and the defects that might influence the quality, customers satisfaction, revenues and other processes and need a repair.At this stage, the statistical error measurement for every million opportunities (DPMO) is performed (Usman and Hutasoit, 2019)Whereas a team was tasked with monitoring the overfilling and rework taking place across each process step(Dora and Gellynck, 2015).

The third stage is the (Analysis) in which using the analysis instruments for data analysis from the collected defects in the products, services, or the administration (Bandyopadhyay and Coppens, 2005).Intends to examine the root causes of the error or deviation that takes place. Diagram causes and effects are tools which are regularly used in this step (Usman and Hutasoit, 2019).

The fourth stage is (Improve) in which setting the solutions and developing them to get rid of the fundamental problems facing the work to and uncover a solution which can decrease the number of defects (Usman and Hutasoit, 2019). At the same time, the fifth stage is the (Control) which is based on setting specific strategies to prevent the occurrence of problems of errors once again and ensuring the sustainability of these solutions (Sleeper, 2006).

2.4. Importance of Applying Lean Six Sigma and Quality of Product

Importance of lean Six Sigma resides in the fact that it is a developed and contemporary method helps in increasing effectiveness of the productive processes in the companies and helps to reduce the cost and continue to improve the products, to avoid the occurrence of the productive errors, reducing waiting time and delivery times, offering to distinguish product at a relevant and competing price, achieving profits leading at the end to customers' satisfaction (Al Muhareb and Graham-Jones, 2014). Alkunsol et al. (2019) indicate that applying lean Six Sigma helps in encountering and preventing the errors, working appropriately from the beginning while de Mattos Nascimento et al. (2019) have mentioned that it helps in making the correct decisions because it depends on data analysis. Sujar et al. (2008) have reached that lean Six Sigma has removed the unimportant stages in the production process and increased efficacy of the administrative decisions, developed the skills and the capability to offer the best products and services at a high speed.(Omoush et al., 2020) bring to light the Kaizen is one of the most excellently-recognized methods in Ongoing enhancement that facilitates innovative ideas Consumers are generally concerned about the quality, the cost Items and time of delivery.

2.5. Types of Waste that Can be Solved by Using Lean Six Sigma

In the literature, it seems there is an agreement on types of waste that is pertaining to lean Six Sigma namely overproduction, inventory, over-processing, motion, waiting, defects, and transportation (Alkunsol et al., 2019; Arunagiri and Babu, 2013; Poppendieck, 2002; Ramkumar et al., 2019; Stoiljković et al., 2011). However, For the purpose of the current study, four relevant types have been selected as they are most attached to the manufacturing process itself as follows:

1. **The imperfection:** It is a feature in the offered service to the client that does not achieve satisfaction (Hilton, 1999). Since lean Six Sigma methodology is based on preventing the defects before they occur and performing the works accurately, so the companies should be able to measure a number of the defects in the process and the activities to reduce them. This agrees with lean Six Sigma methodology which is based on the continuous improvement for quality from the first time to reach defect-free state, so the defect to work to reduce the cost of the failure and to reach the zero degree (Dora and Gellynck, 2015; Usman and Hutasoit, 2019).In this vein, Slack et al. (2010) stated that the continuous improvement in the activities and the processes dramatically helps in eliminating the defects. So, the prevention and the evaluation cost gradually reduced when applying lean Six Sigma. However, its results do not show instantly; instead, they require time.
2. **Overproduction:** In a nutshell, this means that the company produce more than the actual needs of their customer or earlier than the time required which leads the company to incur additional costs (Awaritoma, 2010; Dumitrescu and Dumitrache, 2011).The overproduction occurs because of several factors, such as the product requires time when manufacturing, so the company works to produce reserve deposit in case of the quick demand, or the production process is based on the predictions without pre-study. This can be overcome through lean Six Sigma methodology by setting the appropriate plans and implementing them accurately to produce what is required at the right time without the need for the presence of surplus (Ramkumar et al., 2019; Subramaniyam et al., 2011).
3. **Waiting time**: A number of researchers have mentioned that this type of waste indicates at wasting time which is the temporal separation between the production steps, for the products to be ready for the next step at the manufacturing stage (Mezouari et al., 2013).But some issues occur that stop the work, delays in the production process, the waiting time might be because of a number of issues, including poor planning, absence of the sufficient experience among the employees, the inefficient communication process between the workers, absence of appropriate volume of the product's components for the manufacturing through lean Six Sigma it is possible to solve this problem through training the employees about how to work, always assuring that the equipment works appropriately without the presence of any problems, and employing the employees with experience (Alkunsol et al., 2019).
4. **The movement:** Briefly, this means that the waste movement without benefit from them on the unnecessary additional movement (Awaritoma, 2010; Dey, 2014).It is possible to lean Six Sigma methodology to solve the problem by accurate planning and the attempts to provide the equipment and determining the tasks (Stoiljković et al., 2011).

3. MANUFACTURING PROCESS

The capability of the manufacturing process is an essential consideration for continuation of the operation. There are specific issues in the manufacturing process which have prompted the manufacturing purpose and quality requirements not to be fulfilled (Costa et al., 2018). In order to reap the maximum benefit in the manufacturing process, the wasteful processes and activities must be prevented as it rises the total processing time, decreases line productivity and consume resources (Engelund et al., 2009). To achieve that, manufacturing companies started to embrace the lean Six Sigma methodology. Unsurprisingly, Six Sigma has several benefits, and the most reported is the reduction and avoidance of defects that influence the consistency of both processes and products (Tjahjono et al., 2010).However, Lean Manufacturing is a systematic method for reducing waste and improving processes simultaneously. In this way, waste is defined and minimised with constant improvement (Dumitrescu and Dumitrache, 2011). Thus, the philosophy of adopting the lean Six Sigma methodology by companies is to enhance the whole process of manufacturing to achieve high-quality standards. To illustrate, lean production was known as a waste management system, and Six Sigma was viewed as a monitoring tool to enhance processes by reducing variance.

The main goal of both methodologies is to recognise the most crucial processes to save a company. Lean Six Sigma integrates these two methods into an efficient hybrid process, which incorporates Six Sigma's tools for reducing complexity with lean manufacturing waste (Dora and Gellynck, 2015; Prieto-Avalos et al., 2014). In sum, by deploying of lean Six Sigma methodology throughout the production process, the company is willing to preventing recurrence of non-conforming products as well as preventing potential causes of non-conforming products (Dora et al., 2014; Prieto-Avalos et al., 2014). It is not only that but the company also keen on ensuring that corrective actions are implemented and effective. Finally, the company keen on documenting necessary changes in procedures resulting from corrective action (Dora and Gellynck, 2015; Kosina, 2013; Prieto-Avalos et al., 2014). In this line, manufacturing is recognized as a modern framework that has recently been adopted in many organizations, mainly aimed at minimizing wasteful spending and removing non-value - added supply activities, In other words, lean manufacturing is capable of carrying out the tasks and operations of the organizations on an ongoing basis to Get a quicker response to customers, while increasing the quality (Omoush, 2020).

4. THEORETİCAL BACKGROUND AND HYPOTHESES DEVELOPMENT

The researcher has conducted a review of several related previous studies. The following is a presentation of these studies:

Hung and Sung (2011) study aimed at applying lean Six Sigma methodology to the manufacturing process in the food industry to reduce quality cost. This study has been applied to a food company in Taiwan. The lean Six Sigma method was used through (defining, measuring, analysing, improving, and controlling) in order to solve fundamental problem represents in reducing the process variance and (defect ratio) the high ratio correlates with the problem.

Results revealed that at the beginning of the project, defect ratio reduced 0.45% and after implementing the improvement procedures during six months defect ratio reduced to 0.41%. Also, results showed that lean Six Sigma methodology had a great influence on reducing quality cost and improving it, reducing defect ratio significantly, and through applying the method many improvements were made in the infrastructure, administrative system and in other domains.

Kaushik et al. (2012) study aimed to apply to lean Six Sigma to small-medium size industrial firm to find out the effects of applying lean Six Sigma to these firms in India, the selected unit was motorcycles industrial unit, to reduce defect ratio related to the processes. Results showed that applying lean Six Sigma methodology has led to reducing defect ratio, liaising level of the process from (1.40) to (5.46) also contributed to increasing the firm's profit ratio.

Hakimi et al. (2018) conducted a study aimed to focus on quality improvement in the process of yoghurt production through applying design instrument to focus on the clients' requirements to improve the process quality specifications in products manufacturing company in Iran. Results showed that fats ratio and incubation period were primary factors in acidity degree, and from the other side, the study revealed the role of lean Six Sigma in the continuous improvement in the processes and developing the new products by using the useful analysis and the statistical methods. The study has argued the companies' managers to apply to lean Six Sigma method to treat the complex problems in other processes that have no apparent reasons.

Hernadewita et al. (2019) study revealed that by using lean Six Sigma method in printing the journals, the production has improved through analysing the product's defects. The study was conducted on (PT.XYZ) company which prints the journals. The company was focusing on quality defects in its prints which have led to increasing the losses in the costs because of production defects led to unsold journals. Six Sigma method used to help controlling production quality.Random samples were taken (100) sample. Results revealed that sigma value for the current production was (3.6) and type of the occurring defect is unclear by (59%) and to lean six corrective sigma steps should be taken by using results of the analysis.

Alkunsol et al. (2019) study aimed to investigate the influence of Six Sigma elements on the performance of the Jordanian pharmaceutical products manufacturing. Data was collected from (120) directors from about (300) directors through questionnaire method.Results showed that there is an agreement about the high implementation of Six Sigma variables between the Jordanian pharmaceuticals manufacturing firms and that all lean Six Sigma variables (the defect, overproduction, waiting time, transportation means, the deposit, additional treatment-the unutilised talents) have an influence on the performance of the Jordanian pharmaceuticals manufacturing companies. Further, Defect or disorder has the most significant influence on the performance of these companies.

All these studies and others asserted the critical role of applying lean Six Sigma methodology. However, it is apparent that the outcome of applying this methodology is connected to the context of the company and particular to its operations and industry (Alkunsol et al., 2019; Costa et al., 2020). The impact of deploying lean Six Sigma to food companies to achieve the willing of these companies to produce errors free products with high-quality is associated with the manufacturing process (Costa et al., 2018). The need to eliminate and preventing future wastes is relevant to the evaluation of each element (defects, motion, waiting time, overproduction) impact on the quality through the manufacturing process (Belekoukias et al., 2014). Hence, More studies are required to prioritise and measure this impact in the food industry as the number of studies still shallow compared to other industries (Costa et al., 2020).

One of the key steps in the Lean and TPS phase is to define- practices add value and which do not, and then work progressively to enhance or remove them in order to produce the best results. Seven types of waste Ohno, (1988), originally identified by Taiichi Ohno, the "father" of the Toyota Production System. But only four variables that were based on depending on Ohno were discussed in this study. Following Figure 1 shows the interactions of the study variables.

5. METHODS AND RESULTS

The descriptive analytical method used in that approach was used by appropriate references, sources and periodicals, theoretical theory, as well as field research, while conducting data collection, information and event objectives study, in which data were collected from two complementary sources. It includes collecting data through the study tool (a questionnaire developed) for the purpose this study and its statistical analysis through the use of the Statistical Package for Science (SPSS V23) to answer the study questions and test its hypotheses. The questionnaire was distributed to a sample of 180 respondents, and the number of returned items was 142. The study applied a purposive sample of those holding positions related to quality management, production and research development (R&D) at Jordanian food industry.

5.1. Questionnaire

In this study, the literature referred to the questionnaire produced by the investigator, including respondent characteristics as it appeared in Table 1 (gender, experience, Department, and Managerial level) The second portion of the questionnaire consists of five points based on (Omoush, 2020) on the Likert scale from 1 (strongly disagreed) to 5 (strongly agreed) (Saunders et al., 2007). For the purpose of analysis, four five elements of independent and dependent are used and 4 items from the moderating variables. The questionnaire (items) questions were based on the following study (al Kunsol, 2015) only in the independent variables. The theoretical principles were based on the dependent variable and the items were derived from them, and the moderating variable was considered in this analysis to be the procedures and activities performed by companies to achieve the quality of goods.

Table 2 indicates the reliability results using the approach of cronbach alpha. The values ranged between (0.714) for Quality of product (dependent variable) and (0.915) for the Lean Six Sigma(Independent Variable). Given that the maximum value that could be achieved is (1.00), the reliability values referred to reflect a high acceptable level.

5.2. First; Analyzing the İndependent Variable (Lean Six Sigma)

Means, standard deviations, and mean indices (MI) were calculated for each item. Table 3 below reflects the results the researcher relied on the following scale to describe the mean values.

The mean values and standard deviation MI of the independent variable elements (from Lean Six Sigma) are shown in Table 3. The component (movement) and (waiting time) share the highest average among the other variables, as they rated first with an average (4.35), while the component of overproduction scored the lowest item.

Table 1: Demographic characteristics

variable	Sections	Counts	%
Gender	Males	67	47.2
	Females	75	52.8
	Total	142	100.0
Experience	35-25	15	10.6
	45-35	58	40.8
	55-45	38	26.8
	mor of 55	31	21.8
	Total	142	100.0
Department	Research and development	17	12.0
	Operation	34	23.9
	Quality management	27	19.0
	Control management	64	45.1
	Total	142	100.0
Managerial level	Top level	61	43.0
	Middle level	55	38.7
	Low level;	26	18.3
	Total	142	100.0

Figure 1: Hypothesis model

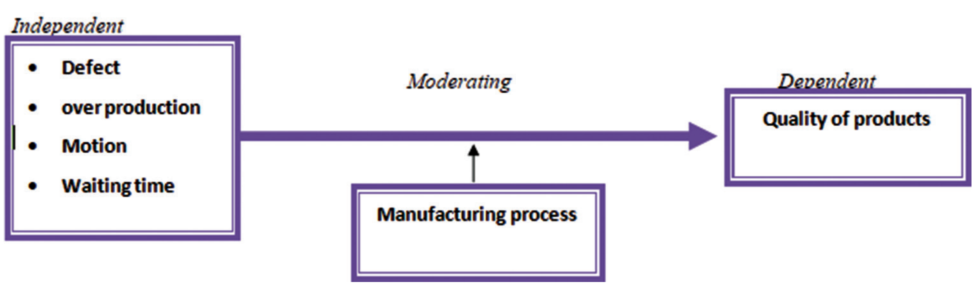

Table 4 shows the mean and standard deviation values, the MI for the Defect element. Inspecting the items means that it can be clearly seen that item No. 1 "The organization has used quality improvement in its operations and the procedures have greatly led to the reduction of defects." was the largest item to be measured by the study sample as rated first by means of (4.38) above.

Table 5 shows the mean and standard deviation values, the MI for the overproduction element. Exploring the items' means it was obvious that Item no. 1 "Before going into production, the organization focuses the order." had recorded the greatest mean as it ranked the first by a mean of (4.42) on the other hand item no. 3 which states "The organization is involved in estimating the raw materials needed for production." and item no. 4 which states "The organization continues to manage the equipment accurately and comfortably" The least mean recorded (among the products as its mean was 4.20). The overall assessment level of (over-production) was averaged (4.29). This value reflects a high degree of consensus between the study samples.

Table 6 indicates the means and standard deviation values, MI for the Motion element Analyzing the items means that the item can be decided no. 1 "The organization is keen to minimize the movement of employees who are not linked to work" had shown the highest item's mean being assessed as it ranked the first (4.37) while item no. 3 which states "The business is committed to use suitable internal means of transport between department and section) had been evaluated by the least mean as its mean was (4.24).The overall assessment level of (Motion) was rated by a mean of (4.35). This value reflects a high degree of consensus between the sample study

Table 7 indicates the means and standard deviation values, MI for the waiting time element. Analyzing the items means that the item can be decided no. Referring to the items means it can be detected that Item no. 5 "The organization sets goals for manufacturing techniques" reflected the largest mean being assessed as it ranked the first (4.42) in opposite, item no. 3 which states "The organization operates on the supply of materials in a timely way." had recorded the least mean (4.27) The overall assessment level of (Waiting time) was rated by a mean of (4.35). This value reflects a high degree of consensus between the sample study.

Table 8 identifies the mean and standard deviation values, MI for the consistency of the goods. Looking at the mean column, it can be noted that Item No.4, "The goods of our organization are extremely secure for use." was the most item to be scored by the study sample as the first item by the mean of (4.40) while Item No. 2, which says, "The organization evaluated its goods for favorable results"

The overall evaluation level for (product quality) was estimated at an average of (4.30). This value expresses a high level of compatibility between the sample study.

Table 2: Reliability analysis results for study variables using cronbach alpha

Variables		No. of items	Reliability
IV	Defect	5	0.843
	Over production	5	0.827
	Motion	5	0.826
	Waiting time	5	0.815
	Lean Six Sigma	20	0.915
DV	Quality of product	5	0.714
MV	Manufacturing Process	4	0.863

Table 3: The arithmetic means, standard deviations, and MI of the items from (Lean Six Sigma element) are arranged in descending order

No.	Elements of Lean Six Sigma	M	SD	MI	Level	Rank
1	Defect	4.31	0.53	86.2	High	3
2	Over production	4.29	0.52	85.8	High	4
3	Motion	4.35	0.53	87.0	High	1
4	Waiting time	4.35	0.53	87.0	High	1
	Lean Six Sigma	4.33	0.42	86.6	High	

Mean Definition (low 1.00-2.33, medium 2.34-3.67, and strong 3.68-5.00)

Table 4: The arithmetic means, standard deviations, and MI of the items from (defect) are arranged in descending order

Item code	Items	M	SD	MI	Level	Rank
xa1	The organization has used quality improvement in its operations and procedures have significantly contributed to the reduction of defects.	4.38	0.57	87.6	High	1
xa2	The organizations utilize the necessary means of transport	4.33	0.67	86.6	High	2
xa5	The organizations is committed to the quality of the raw marital product	4.32	0.67	86.4	High	3
xa3	The organizations It is willing to pay attention to the cleanliness of the internal environment	4.28	0.75	85.6	High	4
xa4	The organization is able to pursue the manufacturing processes in time	4.24	0.72	84.8	High	5
	Defect	4.31	0.53	86.2	High	

Table 5: The arithmetic means, standard deviations, and MI of the items from (over production) are arranged in descending order

Item code	Items	M	SD	MI	Level	Rank
xb1	Before going into production, the organization focuses the order.	4.42	0.61	88.4	High	1
xb5	The organization is committed to delivering a product based on customer orders.	4.35	0.60	87.0	High	2
xb2	The organization is involved in accurately determining the quantity of the order	4.28	0.68	85.6	High	3
xb3	The organization is involved in estimating the raw materials needed for production.	4.20	0.82	84.0	High	4
xb4	The organization continues to manage the equipment accurately and comfortably	4.20	0.67	84.0	High	4
	Over production	4.29	0.52	85.8	High	

Table 9 indicates the values of means and standard deviation, MI for the moderator variable Manufacturing Process. Item no. 1 "The organization is careful to avoid non-conforming goods from repeating." was the most item being rated (4.34) while item no. 4 which states "The organization is involved in recording the required procedural changes resulting from corrective measures." was the least item being rated by the study sample as its mean was the least (4.01).

The overall assessment level of (Manufacturing Process) was assessed by a mean of (4.19). This value reflects a high degree of consensus between the sample study.

5.3. Testing the hypothesis

5.3.1. The first main hypothesis

n addition to the degree of linear multiplicity between independent variables, the normal status of the data distribution was defined by declination, while linear regression was used to search at some simple conditions, while co linearity was tested using the VIF (variance amplification factor) test, the results are shown in the following table.

Table 10 it implies the ideals of skewedness. When the values vary between (-3 and +3), the values are assumed to be similar to the normal distribution. The values listed mean that the data distributions of the sample variables were similar to the normal distribution (Marquardt, 1970).

The results of the VIF referred to in the table vary between (1.371) for element six sigma and (1.675) for product quality. These values are well below the (5) value considered to express low co-linearity (i.e. low independent variable correlation: (Brace, 2003). A value of VIF more than 30 is considered to be a major problem, a value > 10 leads to un trusty with the obtained coefficients, a value between 5 and 10 represents a moderate problem, <5 simple problems,

H01: element Lean Six sigma statistically does not affect the quality of product at ($\alpha \leq 0.05$) in Jordanian Food Companies.

Table 6: The arithmetic means, standard deviations, and MI of the items from (motion) are arranged in descending order

Item code	Items	M	SD	MI	Level	Rank
xc1	The organization is keen to minimize the movement of employees who are not linked to work	4.37	0.64	87.4	High	1
xc5	The organization needs a successful arrangement for the factory to reduce unnecessary movement.	4.44	0.62	88.8	High	2
xc4	The organization is committed to hiring an sufficient number of employees	4.40	0.71	88.0	High	3
xc2	The organization is willing to have a regular job	4.32	0.73	86.4	High	4
xc3	The business is committed to use suitable internal means of transport between department and section	4.24	0.72	84.8	High	5
	Motion	4.35	0.53	87.0	High	

Table 7: The arithmetic means, standard deviations, and MI of the items from (waiting time) are arranged in descending order

Item code	Items	M	SD	MI	Level	Rank
xd5	The organization sets goals for manufacturing techniques	4.42	0.66	88.4	High	1
xd4	The organization is involved in the quality of the manufacturing process.	4.40	0.67	88.0	High	2
xd1	The organization has taken into account the speeding up of decision-making when the need arises.	4.37	0.64	87.4	High	3
xd2	The organization which employs the experienced employees.	4.29	0.79	85.8	High	4
xd3	The organization operates on the supply of materials in a timely way.	4.27	0.71	85.4	High	5
	Waiting time	4.35	0.53	87.0	High	

Table 8: The arithmetic means, standard deviations, and MI of the items from Quality of product) are arranged in descending order

Item code	Items	M	SD	MI	Level	Rank
d4	The goods of our organization are extremely secure for use.	4.40	0.65	88.0	High	1
d5	The probability of incompetence of the products of the business is very minimal.	4.33	0.75	86.6	High	2
d1	The products of the company outperform the products of the rivals in results	4.30	0.76	86.0	High	3
d3	Our clients want high-performance goods	4.27	0.75	85.4	High	4
d2	The organization evaluated its goods for favorable performance	4.20	0.73	84.0	High	5
	Quality of product	4.30	0.59	86.0	High	

Table 9: The arithmetic means, standard deviations, and MI of the items from (manufacturing process) are arranged in descending order

Item code	Items	M	SD	MI	Level	Rank
m1	The organization is careful to avoid non-conforming goods from repeating.	4.34	0.70	86.8	High	1
m2	The business is eager to eradicate possible triggers of non-conforming goods	4.26	0.70	85.2	High	2
m3	The organization is committed to ensuring that correction steps are enforced and are successful.	4.15	0.84	83.0	High	3
m4	The organization is involved in recording the required procedural changes resulting from corrective measures.	4.01	0.79	80.2	High	4
	Manufacturing Process	4.19	0.56	83.8	High	

A further analysis of the effect of the lean six sigma elements was carried out by observing the simultaneous effect of almost all of the three elements working collectively. This helps to distinguish between the variables that contribute significantly to explaining the variance monitored in the estimation of the dependent variable and to distinguish between the impacts values (expressed by the beta coefficients). Multiple linear regressions were performed for this purpose. The findings are submitted in the Tables 11.

Table 11 presents the results of multiple linear regressions to explore the impact of the lean six sigma on the quality of production. The calculated f value was found (33.03), this value is considered to be significant because the associated p value (0.000) was < 0.05 i.e. statistically significant).

The R2 predictor reflects the percentage of variation found in the dependent variable when measuring this using the independent variable. R2 was found to be (49.1 percent) stated as a percent for this model. The R2 changed is the R2 updated. The modified R2 is used as a better measure for the predicted R2 populations. Obviously, the variance between the two values is so small that the current R2 sample represents a strong predictor of population variation.

As a result, and relying on the sig value of f (0.000) the study hypothesis is rejected concluding that the elements of lean six sigma affects the quality of product.

Table 12 presents the results of beta coefficient represents the value of each effect (element). The findings reflect the simultaneous influence of the dependent variable on all the elements described. Therefore, a substantial explanation of the difference in the dependent variable was shown by the Defect and Overproduction elements.

On the other hand, in the dependent variable, the other two remaining elements did not contribute to the variance interpretation. To test the sub-hypothesis, the data given by this table will be used.

Sub hypotheses of the first main hypothesis

Table 10: Normality and the VIF test (multi co linearity detection)

Variables	Skewness	VIF
Defect	−0.53	1.430
Over production	−0.41	1.535
Motion	−0.71	7.084
Waiting time	−0.66	6.852
Lean six sigma	−0.89	-
Quality of products	−0.50	-
Manufacturing process	−0.36	-

H01-$_1$: Defect statistically affects the quality of products at ($\alpha \leq 0.05$) in Jordanian Food Companies.

Referring to Table 12 the effect t value assigned to the defect's element was (.393), this impact value was positive meaning that if the dependent variable (quality of products) increases by one unit the defects will increase by the mentioned impact value. Consulting the probability (statistical significance) value (0.000) it was clear that the probability value was < 0.05 suggesting significant statistical impact to on the dependent variable.

Accordingly, this hypothesis was rejected concluding that Defect affects the dependent variable.

H01-$_2$: Over production statistically affects the quality of product at ($\alpha \leq 0.05$) in Jordanian Food Companies.

According to the consequences of Table 12 the effect value assigned to the Overproduction element was (.159), this impact value was positive meaning that if the dependent variable (quality of products) increases by one unit the Over production will increase by the mentioned impact value. Consulting the probability (statistical significance) value (0.037) it was clear that the probability value was < 0.05 suggesting significant statistical impact to on the dependent variable.

Accordingly, this hypothesis was rejected concluding that Overproduction affects the dependent variable.

H01-$_3$: Motion statistically affects the quality of product at ($\alpha \leq 0.05$) in Jordanian Food Companies.

Relying on the consequences of Table 12 the effect value assigned to the Motion element was (.137), this impact value was positive meaning that if the dependent variable (quality of products) increases by one unit the Motion will increase by the mentioned impact value. Consulting the probability (statistical significance) value (0.589) it was clear that the probability value was > 0.05 suggesting no significant statistical impact to on the dependent variable.

Accordingly, this hypothesis was accepted concluding the motion did not affect the dependent variable.

H01-$_4$: Waiting time statistically affects the quality of product at ($\alpha \leq 0.05$) in Jordanian Food Companies.

Back to the consequences of Table 12 the effect t value assigned to the Waiting time element was (.185), this impact value was positive

Table 11: Multiple linear regression for testing the impact of the elements of lean six sigma on the quality of product

Variables	Model indicators								
	Coefficient of determination			ANOVA results					
	r	R^2	Adjusted R^2	Source	Sum of square	df	MS	f	Sig
Defect							5.96		
Over production	0.701	0.491	0.476	Regression	23.87	4			
Motion				Residual	24.74	137	0.181	33.03	0.000
Waiting time				total	48.62	141			

meaning that if the dependent variable (quality of products) increases by one unit the Waiting time will increase by the mentioned impact value. Consulting the probability (statistical significance) value (0.460) it was clear that the probability value was > 0.05 suggesting no significant statistical impact on the dependent variable.

Accordingly, this hypothesis was accepted concluding the Waiting time did not affect the dependent variable.

H02: Manufacturing Process has no moderation effect on the relationship between the lean six sigma variable and the quality of product α ≤ (0.05).

To test this hypothesis the Process macro developed by F. Hays (2015) was used (under SPSS version (23). The results are included in the next table.

Table 13 appeared the results as a moderator, the direct effect of the lean six sigma is illustrated by (β= 0.764). It was not significantly positive as the t statistics' sig value (0.031) was ≤ 0.05 and concluded that the moderator's direct effect is statistically accepted.

The direct effect value (expressed by β= 1.745) of the independent variable was significantly positive as the sig value (0.019) of the t statistics was < 0.05.

Effect value (expressed by β=-0.186) regarding the moderation effect (interaction between independent and moderator). It was significantly positive as the t statistics' sig value (0.028) was 0.05 and concluded that the effect of the moderator variable is accepted statistically.

In addition, the R2 of the original model was (0.500), with R2 increasing by (0.0051) for the model including the moderator. Due to the inclusion of the moderator in the model, this rise has been clarified. This small percentage was tested for significance that the associated sig value (0.028) was around 0.05, implying that the addition of the moderator variable would account for more R2 (statistically).

Founded on the sig value (0.028) the null hypothesis is rejected and the alternative one is accepted.

H02-$_1$: Manufacturing Process has no moderation effect on the relationship between the Defect element and the quality of production at α ≤ (0.05).

Table 14 appear the consequences as a moderator, the direct effect of the lean six sigma is illustrated by (β= 0.382). It was not significantly positive as the t statistics' sig value (0.047) was ≤ 0.05 and implied that the moderator's direct effect is statistically accepted.

The significant effect value (expressed by β= 1.128) of the independent variable was significantly positive as the sig value (0.029) of the t statistics was < 0.05.

Effect value (expressed by β=-0.107) regarding the moderation effect (interaction between independent and moderator). As the sig value (0.037) of the t statistics was > 0.05, it was not significantly positive, concluding that the influence of the moderator variable is statistically accepted.

In addition, the R2 of the previous model was (0. 466), the R2 improved by R2 for the model including the moderator by (0. 0047). Due to the inclusion of the moderator in the model, this rise has been clarified. This small sum was tested for statistical significance; the associated sig value (0.037) was obviously 0.05, meaning that more R2 would (statistically) be accounted for by the addition of the moderator variable.

Based on the sig value (0.037) the null hypothesis is rejected and the alternative one is accepted.

H02-$_2$: Manufacturing Process has no moderation effect on the relationship between the Overproduction element and the quality of products at α ≤ (0.05).

Table 15 appear the results the direct effect as a moderator of the lean six sigma is illustrated by (β = −0.026). It was not significantly

Table 12: Effect values for the elements of lean six sigma

Elements	B	SE	β	t	Sig
Defect	0.439	0.081	0.393	5.394	0.000
Over production	0.179	0.085	0.159	2.105	0.037
Motion	0.153	0.281	0.137	0.542	0.589
Waiting time	0.206	0.279	0.185	0.741	0.460

Table 13: The effect of moderation of manufacturing process on the relationship among lean six sigma and quality of products

Model adjust				Coefficients			
R^2	R^2-Change	F - change	Sig(f)	Model variables	β	t	Sig(t)
0.500	0.0051	1.174	0.028	Moderator (MV)	0.764	1.01	0.031
				Independent (IV)	1.745	2.36	0.019
				Moderation effect	−0.186	−1.08	0.028

Table 14: The effect of moderation of manufacturing process on the relationship between defect and quality of products

Model adjust				Coefficients			
R^2	R^2 -Change	F - change	Sig(f)	Model variables	β	t	Sig(t)
0.466	0.0047	0.777	0.037	Moderator (MV)	0.382	0.72	0.047
				Independent (IV)	1.128	2.20	0.029
				Moderation effect	−0.107	−0.88	0.037

positive as the t statistics' sig value (0.047) was greater than 0.05 and concluded that the moderator's direct effect is statistically accepted. The independent variable's direct effect value (expressed by β=0.640) was statistically positive as the t statistics' sig value (0.030) was more than 0.05.

Effect value (expressed by β=-0.012) regarding the moderation effect (interaction between independent and moderator). It was significantly positive as the t statistics' sig value (0.031) was 0.05 and implied that the effect of the moderator variable is accepted statistically.

Furthermore, the R2 of the previous design was (0. 450), the R2 improved R2 by (0.0046) for the model including the moderator. The rise was clearly due to the addition of the moderator to the model. The related sig value (0031) was 0.05 and this very small sum (almost null) was tested for significance, indicating that the addition of the moderator variable would (statistically) provide for more R2

The null hypothesis is based on the sig (0.031) value for the effect of moderation interaction and the rejected and the alternative one is accepted.

$H02-_3$: Manufacturing Process has no moderation effect on the relationship between the Motion element and the quality of products at $\alpha \leq (0.05)$.

Table 16 come out the results as a moderator, the direct effect of the lean six sigma is expressed by (β=−0.010). It was significantly positive as the t statistics' sig value (0038) was≤ 0.05 and suggested that the moderator's direct effect is statistically accepted.

The independent variable's direct effect value (expressed by β= 1.561) was statistically positive as the t statistics' sig value (0.042) was more than of 0.05.

Effect value (expressed by β=0.010) regarding the moderation effect (interaction between independent and moderator). As the sig value (0.048) of the t statistics was ≤ 0.05, it was significantly positive, concluding that the influence of the moderator variable is statistically accepted.

In fact, the R2 of the previous model was (0. 445), with R2 rising by (0.0045) for the model including the moderator. The rise was clearly due to the addition of the moderator to the model. The relative sig value (0.048) was 0.05 and this very small sum was tested for significance, indicating that the addition of the moderator variable would (statistically) account for even more R2.

Based on the sig value (0.048) for the effect of moderation interaction, the null hypothesis is rejected and the alternative one is accepted.

$H02-_4$: Manufacturing Process has no moderation effect on the relationship between the Waiting time element and the quality of products at $\alpha \leq (0.05)$.

Table 17 come out the results the direct effect of the lean six sigma is expressed as a moderator (β=−0.398). It was significantly positive as the t statistics' sig value (0.037) was more than of 0.05 and indicated that the moderator's direct effect is accepted statistically.

The independent variable's direct impact value (expressed by β=0.199) was statistically positive as the t statistics' sig value (0.036) was more than of 0.05.

Effect value (expressed by β=0.094) regarding the moderation effect (interaction between independent and moderator). It was significantly positive since the sig value (0.045) of t statistics was ≤ 0.05 and indicated that the effect of the moderator variable was statistically accepted.

Table 15: The effect of moderation of manufacturing process on the relationship between Over production and quality of products

Model adjust				Coefficients			
R^2	R^2-Change	F - change	Sig(f)	Model variables	β	t	Sig(t)
0.450	0.0046	0.0075	0.031	Moderator (MV)	−0.026	−0.041	0.047
				Independent (IV)	0.640	1.019	0.030
				Moderation effect	−0.012	−0.086	0.031

Table 16: The effect of moderation of manufacturing process on the relationship between motion and quality of products

Model adjust				Coefficients			
R^2	R^2-Change	F - change	Sig(f)	Model variables	β	t	Sig(t)
0.445	0.0045	0.0041	0.048	Moderator (MV)	−0.010	−0.013	0.038
				Independent (IV)	0.561	0.793	0.042
				Moderation effect	0.010	0.064	0.048

Table 17: The effect of moderation of manufacturing process on the relationship between Waiting time and quality of products

Model adjust				Coefficients			
R^2	R^2 -Change	F - change	Sig(f)	Model variables	β	t	Sig(t)
0.477	0.0048	0.332	0.045	Moderator (MV)	−0.398	−0.544	0.037
				Independent (IV)	0.199	0.284	0.036
				Moderation effect	0.094	0.576	0.045

In fact, the R2 of the previous model was (0.477), with R2 raising by (0.0048) for the model including the moderator. Due to the inclusion of the moderator variable in the model, this increase was justified. The related sig value (0.045) was checked for significance at 0.05, indicating that adding the moderator variable would (statistically) provide for more R2.

Derived from the sig value (0.045) for the effect of moderation interaction, the null hypothesis is rejected and the alternative one is acceptance.

6. CONCLUSİON

- The study focused on the lean six sigma practices to reduce the defects, the waiting time, the motion, and the overproduction.
- The study focused on the moderating production role on the impact of lean six sigma on the quality of the products in the Jordanian food and beverage firms.
- The study Provide recommendations that emphasized on practical activities that are part of the manufacturing process to achieve good quality of product based on result of available study. The main goal of such activities is to reach out and attain the production of high-quality products in the Jordanian manufacturing firms.
- As a result, and based on a multiple regression analysis, embraces the alternative hypothesis that the lean six sigma element sinfluence the consistency of the goods, with the exception of motion and waiting time variables from the point of view of the respondent.
- As a result, the Manufacturing process has a positive moderating impact on the relationship between the six-sigma lean variable and the overall quality of the product.

6.1. Limitation and Future Research

One of the drawbacks of the study is it was limited to Jordanian food industry companies and discussed only four elements of Six Sigma, as its findings are generalized only to the Jordanian industrial sector in order to achieve the quality of tangible products with a significant proportion of the quality of the products. In the future will be taken all the elements of Six Sigma and applied to the service sector to serve non-tangible, such as hospitals, hotels, universities in Jordan.

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