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The Internal Lean Dimensions Impact on the Manufacturing Based Product Quality of Food Processing Companies in Jordan

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Abstract

This paper studies the impact of internal lean dimensions on the manufacturing based quality of food processing companies in Jordan, variables such as, pull systems, continuous flow, setup time reduction, total productive maintenance, statistical process control, and employee involvement were chosen to represent the internal lean dimensions, and were assumed to have an affect manufacturing based quality.

A survey questionnaire was distributed for that purpose to those who occupy positions in the production department and eligible enough to give accurate and unbiased responses to the items of the questionnaire. The results of the study revealed that; the Internal Lean Dimensions have a significant impact on the manufacturing based product quality, manifested by, lower food products reprocessing, conforming to high quality standards, lower defects rate, less interruptive breakdowns, which helped food processing companies in delivering their products according to agreed upon schedule and the optimization of the utilization of their manufacturing resources, such as machines and equipments, raw materials, and labor force.

Keywords: Internal lean, Product Quality, Food Processing, Jordan

1. Introduction

Lean production has been one of the most popular paradigms in waste elimination in the manufacturing and service industry, therefore, many firms have grabbed the benefits to practice lean manufacturing in order to enhance quality and productivity

(Wahab, Mukhtar,et al.,2013), it is an approach that emphasizes attaining value efficiently, its application in industries, such as the automotive industry, has brought about significant performance improvement (Womack et al, 1990), it can also be applied to all aspects of a business from design, through production to distribution of either goods or services. Lean production's perhaps most unique principle is the relentless pursuit of waste which is everything that does not add value to the product (Monden, 1983).

The term Lean Production was developed by Toyota executive Taiichi Ohno (1912-90) during the post-Second World War reconstruction period in Japan, and popularized by James P. Womack and Daniel T. Jones in their 1996 book 'Lean Thinking, Also called lean production. The usage of the term "lean" has also been extended to other meanings. Womack and Jones (1994) use the term "the lean enterprise" to characterize a group of companies. Others use the term "lean management" to denote general aspects of management (Shadur and Bamber, 1994). Finally, the term "lean thinking" has been used to denote several aspects of organizational life (Womack and Jones, 1996).

The supported goals of lean manufacturing systems differ between various authors. While some maintain an internal focus and concern, such as increasing profit for the organization (Liker, 2004), others still claim that improvements should be done according to customer preferences (Bechino, 2004).

Today, “lean” may no longer be luxurious, but its core principles, such as flow, value, pull, minimizing waste, etc. have become the paradigm for many manufacturing and service operations (Lewis, 2000), but to measure its impact on organizational performance, it is necessary to develop competitive skills (Dyer & Singh, 1998) or operational capabilities associated with quality, flexibility and costs (Ferdows & Meyer, 1990; Flynn & Flynn, 2004).

A study conducted by (Fullerton and Wempe, 2009) provides substantial evidence that utilization of non-financial performance measures such as quality, mediates the relationship between lean manufacturing and financial performance.

2. The research problem and its background

During the last three decades, Jordanian food industries, have achieved a lot of success in the technical and economic fields. They have improved quality and have kept up with related Arab and international developments. At the beginning they prospered under direct government protection, support, and contribution. In some sub-sectors, including the canned food production sector, the companies were established by individual and family businesses with relatively small investments. Later, they took the form of shareholding companies, and were restricted to Jordanian investments. In an effort to further enhance the investment environment in the country, Jordan concluded over 35 agreements on protection and

promotion of investments. Additionally, there have been over (30) agreements on the avoidance of double taxation with Arab and non-Arab countries (Jordan competitiveness report, 2008-2009).

A workshop on "the reality of food industries in Jordan; obstacles and suggested solutions" recommended the adoption of modern food production technologies to reduce the food production cost and to take advantage of government support in the form of conducting diagnostic studies and the development of strategies and action plans to raise administrative and production capacity. They also emphasized on the integration and cooperation among the elements of food supply chain, particularly at the local level to facilitate the exchange of available raw materials needed by the food industry sector.(Addustour Newspaper, 2012).

Based on the above statements, conducting a research on the internal lean dimensions implementation and its impact on the manufacturing based product quality of the food processing companies in Jordan is a timely one and partially converts the said workshop recommendations into action, therefore the main research problem is:

What is the Internal Lean impact on the manufacturing based product quality of food processing companies In Jordan.

3. Review of Related literature and research hypothesis

LP can be defined as ‘‘an integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability’’ (Shah and Ward, 2007, p. 791), Lean manufacturing is viewed as an integrated sociotechnical system, which comprises a package of management practices that can be applied to eliminate the waste and reduce the variability of suppliers, customers and internal resources and processes (Anvari, Zulkifli, Yusuff, Ismail, & Hojjati, 2011).A cocktail of factors are needed for lean success; not only is it necessary to implement most of the technical tools but an organization's culture needs transforming too (Bhasin and Burcher, 2006)

Womack and Jones (2003) stated that lean principles can be applied in any industry, therefore, Lean Production has been adopted by many industrial and service organizations, in recent decades these organizations have subsequently moved forward in its implementation. In many cases lean production has enabled them to improve their performance and competitiveness (Moyano-Fuentes and Sacristán-Díaz, 2012).

The characteristics of lean manufacturing were introduced by (Carlson and Ahlstrom, 1996) as the nine variables of leanness: elimination of waste, continues improvement, zero defect, Just In-Time (JIT) delivery, pull of material, multifunctional term, decentralisation, integration of functions, vertical information systems and time to market, wile Womack and Jones (2003) identified the five general principles of lean as: defining the value from customer perspective, mapping the value stream process to achieve the predefined value, creating the flow along the value chain, establishing pull system and pursuing perfection.

Shah and Ward (2007) identified a key set of measurement items by charting the linkages

between measurement instruments that have been used to measure its various components from the past literature, and using a rigorous, two-stage empirical method and data from a large set of manufacturing firms, they narrowed the list of items selected to represent lean production to 48 items, empirically identifying 1underlying components. In doing so, they mapped the operational spaccorresponding conceptual space surrounding lean production. Åhlström (1998) noted that lean manufacturing consists of eight principles: elimination of waste, zero defects, pull scheduling, multifunctional teams, delaying, team leaders, vertical information systems and continuous improvement. He developed a framework for sequencing the lean production principles in the implementation process.

So as to measure the organizational performance at operational level, the measures have to be defined in non-financial terms and also should be related to the lean practices (Neely et al. 2005), A significant amount of research has shown that one of the most effective management control techniques for achieving improved performance is to provide specific, challenging goals and feedback to individuals (Locke 1982).

In their book total quality management (Ross and Perry, 2009) stated that; "Manufacturing-based definitions are concerned primarily with engineering an manufacturing practices and use the universal definition of “conformance to requirements.” Requirements, or specifications, are established design, and any deviation implies a reduction in quality, emphasis on reliability in design and manufacturing tends to address cost reduction as the objective"

The study of (Kuo, Shen et, al., 2008) on relationship between lean production practices and manufacturing performance, revealed; supplier’s involvement and information feedback, would help manufacturing performance, aside from that, internally management, such as controlled process, low setup, productive maintenance and involved employees appears to make a substantial contribution to manufacturing performance, customer involvement was also positively related to manufacturing performance. In addition to that (Karim, Azharul, 2009) emphasized that the quality and reliability of the product is the most important competitive factor for the manufacturers. Product price has become an unimportant factor for manufacturers and the world market has become a battleground for quality and reliability.

A study conducted by (Hallgren, Olhager, 2009) aimed to investigate internal and external factors that drive the choice of lean and agile operations capabilities and their respective impact on operational performance, revealed that, lean and agile manufacturing differ in terms of drivers and outcomes. The choice of a cost-leadership strategy fully mediates the impact of the competitive intensity of industry as a driver of lean manufacturing, while agile manufacturing is directly affected by both internal and external drivers, i.e. a differentiation strategy as well as the competitive intensity of industry. Agile manufacturing is found to be negatively associated with a cost-leadership strategy, emphasizing the difference between lean and agile manufacturing. The major differences in performance outcomes are related to cost and flexibility, such that lean manufacturing has a significant impact on cost performance (whereas agile manufacturing has not), and that agile manufacturing has a stronger relationship with volume as well as product mix flexibility than does lean

manufacturing.

Shah and Ward(2003) argue that, lean bundles such as, just-in-time (JIT), total quality management (TQM), total preventive maintenance (TPM), and human resource management (HRM)) contribute substantially to the operating performance of plants, and explain about 23% of the variation in operational performance after accounting for the effects of industry and contextual factors.

Shahram (2008) conducted a study to investigate the adaptation of lean production and assess its current state of practice in selected industrial sectors in China, he concluded that the petroleum industry is in lead among all industries, followed by computer, wireless telecommunication, and electronics industries. The findings from lean production system design-related questions show lower scores in layout design, volume/mix flexibility, setup, visual factory, and point-of-use delivery. However, plants earned high scores in material flow, scheduling/control, on-time delivery of finished goods, and overall defect rate.

According to the results of (Rahman, Laosirihongthong, et al.,2010) study, the three lean constructs namely just in time (JIT), waste minimization and flow management are significantly related to operational performance. JIT has a higher level of significance in large enterprises(LE) compared with small and medium enterprises (SMEs), whereas for waste minimization there is a higher level of significance for SMEs compared with LEs. Flow management has a much lower level of significance for both SMEs and LEs.

The study of (Dora, Manoj, et al., 2013) analyzed the application of lean manufacturing, its impact on operational performance and critical success factors in the food processing SMEs. The respondents indicated improvement in operational performance, especially with overall productivity from the application of lean manufacturing. Skill of workforce, in-house expertise and organizational culture are critical factors for successful implementation of lean manufacturing practices.

Prattana Punnakitikasem (2014) shows the result of the multiple regression of all lean practices and organizational commitment regressed on the dependent variable operational performance.(Graban 2009) identified operational performance of health care organizations impacted from lean implementation. He summarized operational performance in five categories including speed, cost, overall productivity, quality, and customer satisfaction. Anvari, Zulkifli, and Yusuff (2013) examined the impact of specific influences on the leanness of a manufacturing system. They found that the most crucial components to leanness are defects, cost, lead time and value, (Wan and Frank Chen, 2008) supported the findings of Anvari et al. By emphasizing on cost, value and time in order to evaluate leanness.

Hofer, Eroglu, and Rossiter Hofer (2012) investigated the impact that lean production has on the financial performance of an organization and the mediating role of inventory leanness in proving the economic benefits associated with the deployment of a lean strategy. They found that inventory plays a significant role in the relationship between financial performance and lean production. Furthermore, it turned out that, external lean practices do not have a significant direct effect on financial performance, but that external lean practices affect the

inventory leanness.

Shah and Ward (2007) developed 10 dimensions of a lean system. They are: "SUPPFEED (supplier feedback): provide regular feedback to suppliers about their performance, SUPPJIT (JIT delivery by suppliers): ensures that suppliers deliver the right quantity at the right time in the right place, SUPPDEVT (supplier development): develop suppliers so they can be more involved in the production process of the focal firm, CUSTINV (customer involvement): focus on a firm's customers and their needs, PULL (pull): facilitate JIT production, including Kanban cards which serves as a signal to start or stop production, FLOW(continuous flow): establish mechanisms that enable and ease the continuous flow of products, SETUP (set up time reduction): reduce process downtime between product changeovers, TPM (total productive/preventive maintenance): address equipment downtime through total productive maintenance and thus achieve a high level of equipment availability, SPC (statistical process control): ensure each process will supply defect free units to subsequent process and EMPINV (employee involvement): employees' role in problem solving, and their cross functional character."

In this study, the researcher defines the internal lean manufacturing dimensions as those that can be implemented on the factory shop floor by people who belong to the same manufacturing firm, these dimensions are, pull, continuous flow, setup time reduction, total productive maintenance, statistical process control, and employee involvement..

Based on what have been stated in the previous literature and studies above, the study hypothesis will be summarized as follows;

H01; The internal lean production dimensions; pull, continuous flow, setup time reduction, total productive maintenance, statistical process control, and employee involvement have no impact on the manufacturing based product quality of the food manufacturing companies in Jordan.

4. The conceptual Framework of the study

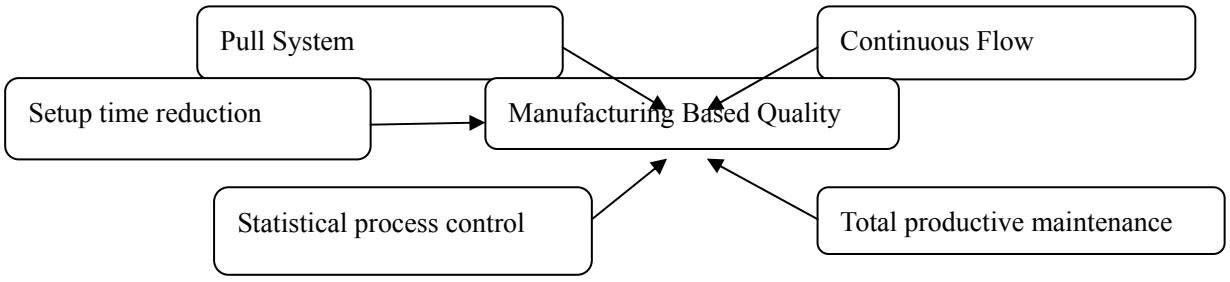

Figure 1. The conceptual framework of the study

The conceptual framework of the study was developed based on (shah and ward, 2007) lean system dimensions.

5. Research Methodology

Secondary and primary data were used for this research, the main research instrument is a

questionnaire based on Shah and Ward 10 dimensions of the lean production systems six of which were chosen to represent the internal side of the lean system, some of the items of the questionnaire were modified based on the suggestions of some academicians specialized in the field of industrial management, and practitioners who belong to the food processing sector, the instrument was translated carefully to Arabic to allow those respondents who are not proficient enough in english to give accurate and reliable responses.

5.1 The population of the study

The population of the study is consisted of employees who occupy either supervisory or managerial positions at the production department of eight major food processing companies that are currently members of the Amman chamber of industry, their total number is 523 employees, therefore, it is possible for the researcher to cover them all and eliminating the need for employing any sampling technique.

The researcher reached only 380 respondents, retrieved 330, and excluded 53 questionnaires for not meeting the statistical treatment criteria, thus only 227 questionnaires were valid for statistical analysis, the table below shows the distribution of the respondents to their respective companies

Table 1. Distribution of respondents according to their demographic profile

Company Frequency Percentage		
Saniora Food Industrial company	41	17.9
Nabil company for food products	37	16.2
Quality Food company limited	29	12.6
Arabia for trade and food industries	31	13.5
Jordan advance for food industry	22	9.6
International teeba for food industries	33	14.5
Delicious food industrial company	36	15.7
Gender		
Male	163	71.2
Female	66	28.8
Educational Background		
Diploma(Intermediate)	41	18
Bachelor	144	62.8
Master	35	15.3
Doctorate	9	3.9
The number of years of experience in their current position		
From 1-3 years	71	31
More than 3 years – 5years	98	42.8
More than five years – 10 years	39	17.1
More than 10 years	21	9.1
Job title		
Manager	6	2.6
Assistant manager	19	8.3
Superintendent	43	18.8
Supervisor	67	29.3
Engineer	94	41
Total	229	100

Table (1) shows that the food processing companies are sufficiently represented by the study, the industrial sector in Jordan is male dominated due to its unattractiveness to female population and some managerial constraints that view the female worker as someone who lacks the flexibility and strength which the nature of the industrial job requires. With regards to the educational attainment and work experience, the table shows; most of the respondents possess the proper education and experience needed for the job.

6. Data analysis and hypothesis testing

The data analysis process involves three stages, that began with the normal distribution test using (K-S) (Kolomogrov-Smirnov Z), then the internal consistency test for the research instrument by applying Cronbach's alpha, and lastly the hypothesis test using multiple

regression analysis.

6.1 Normal distribution test

The test on how close the data of the study to normal distribution using (K-S) (Kolomogrov-Smirnov Z) states that; the null hypothesis is rejected if the statistical probability of (K-S) ≥ 0.05, as shown in the table below

Table 2. Normal distribution test of the study variables

Variable	Normality tests	
	(K-S)	P-value
The Independent Variables: The Internal lean system dimentions		
Pull	1.014	0.255
Continuous flow	1.22	0.106
Setup time reduction	1066	0.206
Total productive maintenance	1.30	0.071
Statistical process control	1.44	0.064
Employee involvement	1.28	0.078
The dependent Variable: Manufacturer perceived quality		
Manufacturer perceived quality	1.046	0.225

The result of normality tests in table (2) shows that the values of (K-S) test are high, with a significance level of more than 0.05 for all variables, therefore we reject the null hypothesis and accept the alternative hypothesis that states; the data are normally distributed, which makes it valid for further statistical analysis.

6.2 Internal consistency test

The study applied the cronbach's alpha measure of internal consistency to find if the items of the research instrument for each variable are closely related, according to (Sekaran, 2002), alpha must be more than 67% for the research instrument to be considered reliable, The measurement results show that the value of Alpha is 79% for al of the seven items of the study which is higher than the minimum value of 67%.

7. Data analysis and research findings

Table 3. The result of the main study hypothesis test

Hypthesis	B	t	P-value	R	R^2
H1	0.358	5.75	0.000	0.62	0.384

Degree of freedom (n-1) = 228, level of freedom (0.05), tabulated t value (1.96)

Table (3) shows a strong positive correlation with a value of (R=0.62) and a coefficient of determination (R^2= 0.384) between the independent and dependent variables, taking the main study null hypothesis (H01) that states; the internal lean production dimensions have no impact on the manufacturing based product quality into consideration, and based on the

calculated value (t=5.755) which is more than the tabulated value (t=1.96), and a calculated probability (p-value=0.000) which is lower than (0.05), we accept the alternative hypothesis; the internal lean production dimensions have an impact on the manufacturing based product quality of food processing companies in Jordan.

Table 4. The results of the sub-hypothesis test of the study

Sub-hypothesis	T	P-value	R	R^2
H01a	2.353	0.020	0.65	0.42
H01b	3.418	0.001	0.55	0.30
H01c	4.52	0.000	.590	0.35
H01d	2.93	0.004	0.69	0.48
H0e	3.040	0.002	0.66	0.44
H0f	8.030	0.000	0.47	0.22

Degree of freedom (n-1) = 228, level of freedom (0.05), tabulated t value (1.96)

Table (4) shows the results of the sub-hypothesis tests of the study, based on the (t) tabulated values, a calculated probability (p-values), correlation values (R) and coefficient of determination(R^2) for each sub-hypothesis, we reject the null hypotheses and accept the alternative hypotheses which conclude that, 0.42 of the total variations in manufacturing based product quality can be explained by its linear relationship with pull systems,0.30 of the total variations in manufacturing based product quality can be explained by its linear relationship with the continuous flow,0.35 of the total variation in the manufacturing based product quality can be explained by its linear relationship with the setup time reduction, 0.48 of the total variations in the manufacturing based product quality can be explained by its linear relationship with the total productive maintenance, 0.44 of the variations in the manufacturing based product quality can be explained by its linear relationship with the statistical process control and 0.22 of the variations in manufacturing based product quality can be explained by its linear relationship with the total productive maintenance.

8. Discussion of results and research conclusions

The results of the study show a strong effect for internal lean system elements on manufacturing based quality, which is manifested by, lower food products reprocessing, conforming to high quality standards, lower defects rate, less interruptive breakdowns that help food processing companies in delivering their products according to agreed upon schedule, in addition to that, companies are able to optimize the utilization of their manufacturing resources, such as machines and equipments, raw materials, and labor force, This is quite similar to the study finding of (Dora, Manoj, et al., 2013) that indicated improvement in operational performance, especially with overall productivity from the application of lean manufacturing at the food processing MSEs.

The effect of pull systems on the manufacturing perceived quality, emphasizes the importance of answering questions of what, how, when, and why to produce, to guarantee that no form of waste will be accumulated and high quality standards can easily be implemented.

When food processing companies classify their products into groups with similar processing and routing requirements, then the chances of producing defective products become lower, and food manufacturing process falls within the control limits, in addition to that, the results indicate; the plant layout and the grouping of equipments is determined mainly by their food product families, and employees practice and work to lower setup times to prevent any delay in the production cycle that leads to delay in production.

Food processing industry in Jordan believes in the power and the influence of statistical process control (SPC) on the quality of their outputs, therefore, a large number of their equipment on the plant floor are currently under SPC and process capability tests, which is manifested by, extensive utilization of different statistical methods to lower process variance.

The results of the study show optimism when it comes to employee involvement in internal lean related decisions; food processing companies in Jordan consider their employees when they form problem solving teams, seek their suggestions regarding the product or process improvement programs, and adopt cross functional training to shop-floor employees to guarantee the continuity production process.

The food processing sector in Jordan dedicates an adequate portion of their daily operation time to planned equipment maintenance related activities and follow a regular schedule for preventive maintenance to avoid any enterruptive breakdown, forth more, they maintain maintenance records and share them with employees to lower the cost, efforts and time needed for routine and nonroutine breakdowns.

9. Study recommendations and future researches

The food industry in Jordan is advised to improve its supply chain performance by developing partnership with their major suppliers through long term contracts and any other possible way that may lead to the improvement of their lean practices in general and internal lean practices in particular.

Jordanian food industry must consider the internationalization option to gain access to foreign markets, benefit from the abundance of agricultural supply in some countries and lower the impact of the political instability in some neighboring countries.

The food sector is advised to be more consolidated through group collaboration and negotiation to reap the benefit of the synergy among its members, which will possibly help them deal with any arising problems and future challenges.

This paper tackled one of the many topics that can still contribute to the competitiveness of the food processing sector in Jordan, hence, the researcher hopes that future papers handling topics such as, Lean operations and supply chain performance and operations agility and quality will also be conducted to increase the efficiency of this sector.

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