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LEAN MANUFACTURING PRACTICES AND SUPPLY CHAIN PERFORMANCE OF SUGAR MANUFACTURING FIRMS IN WESTERN KENYA

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ABSTRACT

Introduction: Western Kenya is the largest producer of sugar in Kenya, supporting about 170,000 smallholder farming households and contributing about 80 percent of the total sugar produced in Kenya. This contribution is however threatened given that the sugar firms in that region are producing sub optimally with obsolete technology. Comparing to related sector, other firms in Kenya such as the tea manufacturing firms have implemented energy efficiency practices so as to manage energy wastage and reduce production costs. Were they to employ effective production methods, they could increase their production significantly. While that is the case, scholars have suggested that adoption of lean manufacturing practices is a panacea to quality addition and waste minimization. Perhaps what these firms need are lean practices.

Purpose: This study interrogated the extent to which the firms have adopted lean manufacturing practices, just-in-time and total quality control and if they have, its effect on supply chain performance.

Methodology: The study targeted and conducted a census on the 11 sugar manufacturing firms in the Western Kenya belt where the procurement managers, line managers, finance managers, production managers, production engineers, quality assurance officers and operations managers of each of the 11 firms (total 87) were targeted. The study employed a descriptive research design to collect quantitative data. Quantitative primary data was collected through questionnaires and analyzed using statistical package for social sciences.

Findings: The findings of the study indicated that the just in time productionand total quality control are positively and significantly associated with supply chain performance of the sugar manufacturing firms.

Unique Contribution to Practice and Policy: The study recommended adoption of just in time production practices such as availing labor on demand in order to manage labor costs, availing resources on demand in order to manage wastage, production on demand in order to manage inventory costs, ordering raw materials from the suppliers only when there is demand for production from customers, having a simplified production design to ensure timely production and having multiple skilled workers to ensure faster production. In addition, in order for the sugar manufacturing firms to increase supply chain performance, there is need to adopt total quality control practices such as having manageable defect prevention costs related to quality planning, putting in place manageable defect prevention costs related to investment in quality related information systems, having manageable appraisal costs related to test and inspection of purchased materials, having manageable appraisal costs related to quality audits, having controllable internal failure costs related to reworks and having manageable internal failure costs related to scrap.

Key Words: *Just in Time Production, Total Quality Control, Supply Chain Performance, Sugar Manufacturing Firms, Kenya*

BACKGROUND

Lean supply chain management practices are one of the ways of reducing waste in organizationsdue to benefits that accrue in adoption of these practices (Margaret, 2013). Adoption of lean supply chain management enables the firms to tailor their supply chain processes and organizational roles to support lean supply chain principles. Organizations within a lean supply chain are able to leverage their own lean journey more easily, delivering better customer value by responding more efficiently, quickly, and predictably to customer needs (Demirbag, Koh, Tatoglu & Zaim, 2006). That, in turn, facilitates the operation of the lean supply chain by creating a virtuous cycle that ultimately translates to superior financial performance for these organizations.Lean has become a strategic method for gaining competitive advantage and even for survival, for manufacturers, retailers and wholesalers. According to Lassalle (2005), the best practices in lean supply chain management include: demand management that involves providing products and services when requested by the customer, cost and waste reduction, process standardization which enables continuous flow, industry standardization, and cultural change and cross enterprise collaboration.

The organizations striving to become lean would benefit from a systematic approach towards building and managing their supply chain (York & Miree, 2004). Lean supply chain requires organizations to examine their business processes in order to identify areas whereby resources are wasted which can be measured in monetary value. This creates a window to minimize wastage and improve on the way of doing things. According to Reichhart and Holweg (2007), lean manufacturing practices includeenvironment lean practices, lean procurement practices, lean transformation practices and lean transportation practices. According to Tsuchiya (2010), lean manufacturing practice is a thought process and philosophy, used to look at a firm whether it is manufacturing, service or any other activity with a supplier and a customer relation with a goal of eliminating non-value added tasks.Most companies in Kenya have a major opportunity to reduce their cost, customer lead-time and cycle time through the application of lean manufacturing practices (Flynn, 2011).

Lean thinking focuses on value-added lean and consists of best practices, tools and techniques from throughout industry with the aims of reducing waste and maximizing the flow and efficiency of the overall system to achieve the ultimate customer satisfaction (Rosenzweig &Easton, 2012). Some of the practices are just-in-time production and total quality control. Just-in-time (JIT) manufacturing is a Japanese management philosophy applied in manufacturing field. It involves having the right items with the right quality and quantity in the right place at the right time (Paneru, 2011). The primary goal for all the companies is customer's satisfaction and if a company cannot reach perfection in this area then all the processes are worthless. JIT is a tool if well implemented, improves firm performance and efficiency through reduction of costs, better quality products and increased production.

According to Vore (2002), total quality control as an innovative approach to maintenance that optimizes equipment effectiveness, eliminates breakdowns, and promotes autonomous maintenance by operators through day-to-day activities involving the total workforce. On the other hand, Bhasin and Burcher (2006) explained that total quality control is an approach to keep the current plant and equipment at its higher productive level through cooperation of all areas of organization. Continuous improvement and quality management programs go hand

in hand as they seek to achieve excellence through improvement.In order to survive, companies must be able to reduce cost, improve quality and provide fast response to the customer needs. One of the ways of achieving that competitive edge is through the implementation of lean practices (Muhammad, 2014).

Consistent with a report by the Kenya National Assembly (2015) on the status of agriculture in Kenya, the sugar industry in Kenya supports the livelihoods of about six million Kenyans directly or indirectly, contributing to rural household economies. Additionally, it contributes up to 11% of the Kenyan GDP. However, the industry has been coupled with decreasing production which has forced the government to import more sugar to meet the increasing demand averaging 900, 000 tonnes annually. Recently, the sector has suffered reduced production from about 635,700 Tonnes in 2015 to 491,100 Tonnes in 2018 of milled sugar (Kenya National Bureau of Statistics, 2019). The reduced production has increased the importation of sugar from 192,100 tonnes in the year 2014 to 986,600 tonnes in the year 2017 (Figure 1). While the country has the potential to produce sugar, it is importing thus affecting the Balance of Trade negatively. This demonstrates a pressing need to facelift the production ways and relook at ways of minimizing wastes and improving production by the sugar manufacturing firms.

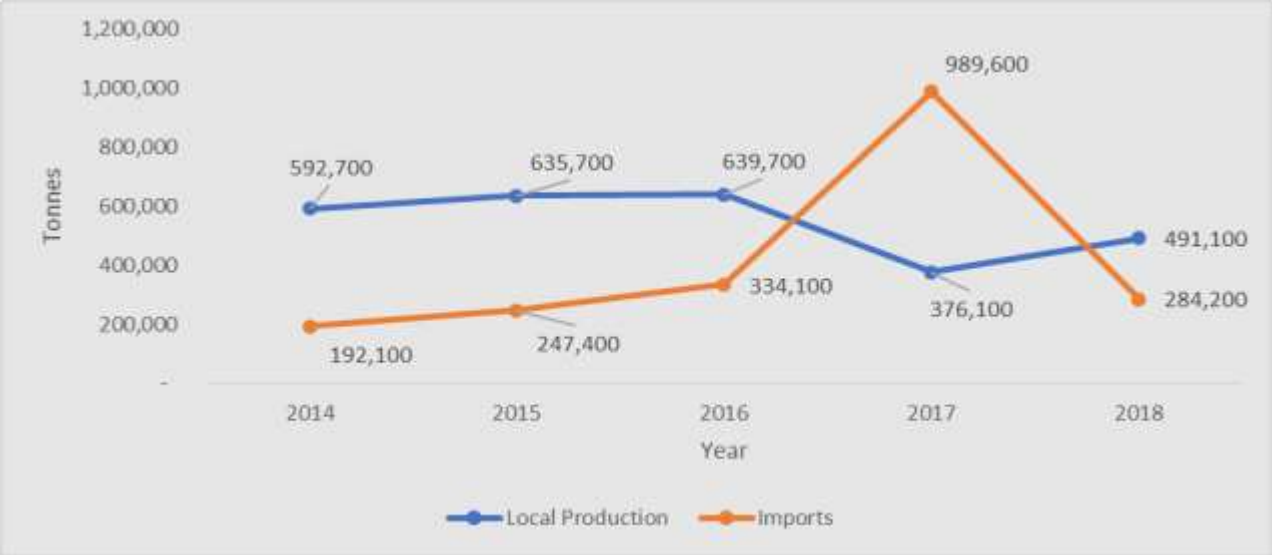


Figure 1: Trends in Sugar Local production and Imports (Tonnes) from 2014 to 2018

Source : KNBS (2019).

STATEMENT OF THE PROBLEM

The importance of lean manufacturing practices cannot be downplayed. Mutua, Ngugi and Odhiambo (2018) documented that lean practices have a direct correlation to the overall performance of the SCM process with 57.1% of the performance of the SCM process being directly determined by wastage and costs. According to Anand and Kodali (2008), reduction of waste is one of the ways that organizations perceive to be appropriate in enhancing organizational performance. Lean supply chain management practices are popular ways of reducing waste in organizations due to benefits that accrue in adoption of these practices for

example reduced waste, value creation, and efficiency and reduced costs among others. Aberdeen group (2006) indicates that more than 50 % of organizations that adopt lean supply chain management practices minimize waste and operational costs.

Western Kenya is the largest producer of sugar in Kenya, supporting about 170,000 smallholder farming households and contributing about 80 percent of the total sugar produced in Kenya (Wawire et al. 2006). This contribution is however threatened based on an argument by Mati and Thomas (2019) that the sugar firms in that region are however producing sub optimally with obsolete technology. Compared to related sector, other firms in Kenya such as the tea manufacturing firms have implemented energy efficiency practices so as to manage energy wastage and reduce production costs (Murigi, 2014). Were they to employ effective production methods, they could increase their production significantly. While that is the case, scholars have suggested that adoption of lean manufacturing practices is a panacea to quality addition and waste minimization. Perhaps what these firms need are lean practices and that is why this study interrogated the extent to which the firms have adopted lean manufacturing practices, and if they have, its effect on supply chain performance.

RESEARCH OBJECTIVES

i. To establish the effect of just in time production on supply chain performance of sugar manufacturing firms in western Kenya

ii. To establish the effect of Total Quality Control on supply chain performance of sugar manufacturing firms in western Kenya

THEORETICAL REVIEW

In explaining the concepts of lean manufacturing on supply chain performance, the literature hinged on Lean Theory and Quality Management Theory. Lean theory forms the basis of this research as it evaluates and brings out lean practices that aim at removing production overburden, inconsistency and minimizing waste. According to Ciarniene and Vienazindiene (2012), lean is a functional modelcomprising of comprehensive techniques which aim at reducing and eliminating wastage when combined together in a production process hence making a firm more responsive and flexible to changes in demand. Nash, Poling and Ward (2006) advanced the theory by seeing it as a systematic approach that aims at enhancing a continuous flow of quality product or service to customers just at the time they need it. According to the theory, processes that aim at fully satisfying customers' needs should follow prescribed principles while minimizing all forms of loss.

Similarly, the operating system should contain stream values that must be individually optimized from the start to the end (Ciarniene& Vienazindiene, 2012). Organizations aiming at applying lean theory in their production lines should have a strong focus on customers, should be willing to remove production wastes from all production processes on daily routine and must be willing to grow and survive prevailing stiff competition. According toMoroz (2018), awell-designed production process should aim at delivering a predictable and consistent product while minimizing wastage. Lean theory capitalizes on a continuous quality delivery to customers basing on customers' needs at specific time. By doing so, the production process eliminates waste characterized by unnecessary planning meetings, unnecessary inventories, overproduction, unnecessary transport and over processing (Rand, 2011).

The theory informed the objective of the effect of just-in-time production on supply chain performance of sugar manufacturing firms. Just-in-time is a strategy applied by firms and alignsordering supplies from suppliers with production schedules (Ciarniene& Vienazindiene, 2012).Firms applying this strategy aim at increasing efficiency while at the same time decreasing waste since they receive goods just when they are needed in production process. The strategy enables producers to accurately forecast demand. Bautista and Fortuny-Santos (2016) asserts that organizations are able to reduce the amount of working capital due to the reduction in inventory levels. Consequently, the strategy ensures step by step inspection of the production process hence minimizing wastage.

On the other hand, Quality Management theory developed by Deming (1954) contributes to this study as it revolves around improving all processes, services, products and cultural workplace in a line of production by all participants to gain a long-term success attained through customer satisfaction. Deming (1954) defines QMT as a managerial approach that focuses on customers coupled with continuous improvements of activities that satisfies customer demands. Consequently, quality management theory aims at centering all process thinking where participants contributes to the transformation of inputs to outputs until they are delivered to consumers. Process thinking defines all the required steps in the production process while at the same time monitoring closely the unexpected variation. Richbell and Ratsiatou (2009) posit that the strength of quality management theory lies on the integration ability that brings together all components of a process for a common goal. Additionally, the integration matches the organization's strategic goals, mission and vision with quality output of products and services that fully satisfies customers. The theory contributes to total quality management of a manufacturing process. Stensaasen, (1995) contends that the aim of every firm is to produce quality goods and services that retaincurrent customers while at the same time attracting other customers. In total quality management, all participants need to be involved for optimal results.

EMPIRICAL REVIEW

Tripathi and Tiwari (2016) conducted a research on lean manufacturing practices and measurement of firm's performance. The purpose of the study was to investigate the extent to which lean manufacturing management practices affects a firm's financial performance of manufacturing firms in India. The findings of the study indicated that firms that applied lean manufacturing practices stood a better competitive position as compared to those that did not apply the lean practices. The system contributes significantly to human resource development that aims at creating a self-directed working culture and a cross functional framework that works jointly towards solving emerging issues in the line of production(Tripathi & Tiwari, 2016).Additionally, just in time production opens a firm's marketing share by ensuring quality products are availed to customer while at the same time minimizing wastage.The findings alsorevealed that just in time production ensures customer retention while attracting new customers.

Sayid (2017) conducted a study on the Implementation of Lean Manufacturing Tools in Footwear Industry of Bangladesh firms. In his study, he evaluated the effects of lean manufacturing, just in time production and single piece flow. The results of the study indicated that just in time production and performance of footwear industryhad a positive link as the latter resulted to a reduction in production cycle, a decrease in the number of operators required to produce equal amount of footwear, reduction of level of reworks, reduction in

wastage and reduction in lead time production. When implemented well, just in time production enables a firm to meet market demands as it is able to produce only what is required at a particular time (Sayid, 2017).

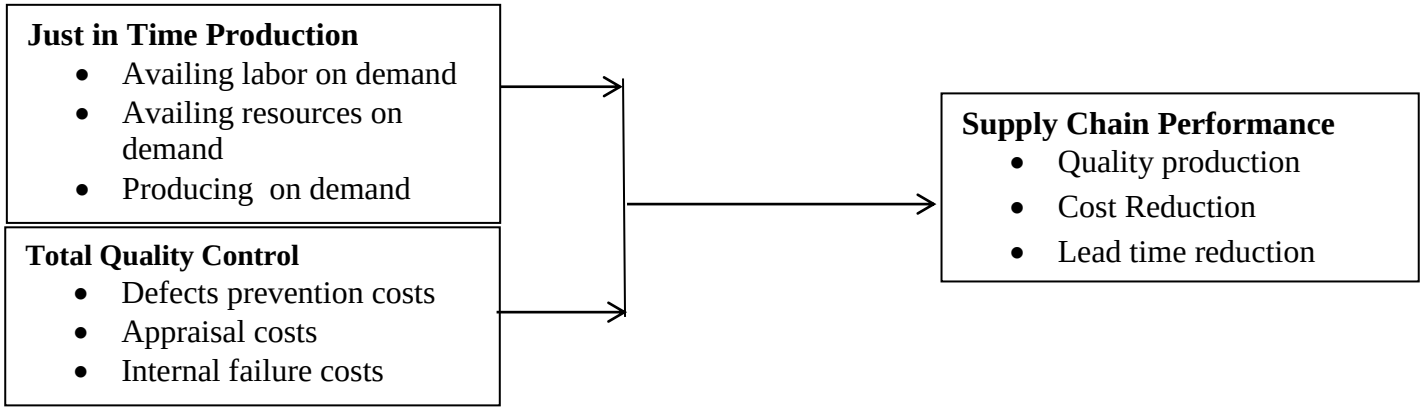
In another study, Sumo(2015) established the relationship between lean assembling practices and supply chainperformance amongst automotive manufacturing firms in Kenya. The study focused on tools of lean practices applied by automotive firms which included value stream mapping, Five (5) Ss, Just in time production and Jidoka. Amongst the lean practices applied by the firms, the study found out that just in time production enabled firms to stay put in the competitive industry by ensuring demand is responded to when it arise. The study concluded that just in time production influences supply chain performance in automotivefirms by ensuring there are supplies only when needed thus enabling a firm to cut costs on inventories and wastage (Sumo, 2015).Masindet and Ogollah (2014) conducted a study on influence of total quality management practices on supply chain performance with a focus on cement manufacturing firms in Kenya. The study applied a descriptive approach which focused on influence of management commitment, employee involvement, customer orientation and continuous improvement on supply performance as key indicators of total quality management. From the results, Masident and Ogollah (2014) established a significant relationship between supply chain performance and all indicators of total quality management since the indicators contributed to supply chain performance of cement manufacturing firms.

Fatuma (2015) carried out a research to establish quality management practices and supply chain performance in large manufacturing firms in Nairobi. Her study emphasized on implementation of quality management practices by manufacturing firms, the relationship between quality management practices and supply chain performance of manufacturing firms and challenges faced by manufacturing firms when implementing quality management practices. The study by Fatuma (2015) adopted a descriptive research design in data collection and analysis presented through descriptive and inferential statistics. The study findings indicated that large manufacturing firmsthat adopted quality management practices characterized by lean production, benchmarking, six sigma practice and supplier partnering stood a better competitive ground in the market. Adoption of quality management practices enables a firm to relate well with all its stakeholders which contributes to a successful accomplishment of set goals and objectives.

A study by Chang (2009) on implication of total quality management on supply chain performance indicated that survival of enterprises in competitive markets is determined by the way a firm applies managerial skills of total quality. According to Chang (2009), existing competition hinders immediate response to customer's demand triggering adoption and implementation of total quality management in the entire production system. Adoption of a system that focuses on total quality management ensures achievement of a simplified production system that leads to achievement of high quality products that fits market demands. This translates into a continuous supply system that ensures availability of products to customers when needed and in the right specified quality. Fatuma (2015) agrees that adoption of total quality management practices translates to performance in the supply chain and enables a firm to respond to demands in the markets.

CONCEPTUAL FRAMEWORK

Independent Variable



Independent Variables **Dependent Variable**

RESEARCH METHODOLOGY

The study used a descriptive survey design which supports establishing a cause-effect relationship between variables just like the study sought to establish. The study targeted and conducted survey of 11 sugar manufacturing firms in the Western Kenya belt which are Chemelil, Muhoroni, Mumias, Nzoia, South Nyanza, Kibos, Sony, Butali, West Kenya, Sukari and Busia (Sugar Board of Kenya, 2020). The study targeted procurement managers, line managers, finance managers, production managers, production engineers, quality assurance officers and operations managers of each of the 11 firms which totaled to 87 target respondents as shown in Table 1.

Table 1: Target Population

Strata	Target Population
Procurement Managers	11
Production Managers	11
Operations Managers	11
Line Managers	11
Finance Managers	11
Production Engineers	21
Quality Assurance Officers	11
Total	**87**

The study conducted a census on the entire population of 11 firms and 87 target respondents. A census was also suitable for this study due to the need to have in depth information as argued by Silverman (2016). The studyuseda questionnaire as the study data collection instrument. Before the use of the questionnaire, a pilot study wasundertaken on 10% of the sample population (8 respondents) selected from other sugar manufacturing. The reliability of the study measures was assessed by computing Cronbach's Alpha coefficient for all items in the questionnaire. All items that had a Cronbach's alpha coefficient of 0.7 or more were

considered reliable. The findings for reliability, presented in Table 2, indicated that all the variables had Cronbach Alpha value above 0.7 to mean that the data was reliable.

Table 2: Reliability Test Results

Variable	Cronbach Coefficient	Number of Items	Decision
Just in Time Production	0.776	7	Reliable
Total Quality Control	0.783	7	Reliable
Supply Chain Performance	0.778	7	Reliable

The data collected was analyzed using descriptive statistics involving percentages and mean scores to determine varying degrees of response-concentration regarding asset disposal practices. In addition, multiple regression analysis wasused to determine the relationship between the study's quantifiable variables. The entire statistical test wasconducted at 5% significance level. The equation below shows the linear regression model of the independent variables against the dependent variable.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \varepsilon \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(i)}$$

Where: Y = Supply Chain Performance; X_1 = Just in Time Production; X_2= Total Quality Control; $\beta_1$toβ_4 are the beta coefficients; ε is the error term and $\beta_0$is the y intercept (Constant).

Classical Linear Regression Assumptions

The regression analysis using the ordinary least square (OLS) model was assumed for this study. However, before its use, the data needed to be examined to ascertain whether it satisfied the assumptions of the model. The study hence conducted diagnostic tests to ensure that the assumptions of ordinary least square were satisfied before conducting a multiple linear regression. Normality test was conducted using Kolmogorov-Smirnov method. Multicollinearity was conducted using a Variance Inflation Factor (VIF) which was applied using the threshold of 10 for severe multicollinearity. Heteroscedasticity was tested using Breusch-Pagan test while Autocorrelation was conducted through Durbin Watson test whereby a DW value between 1.5 and 2.0 indicated absence of the problem of autocorrelation.

RESEARCH FINDINGS

A total of 87 questionnaires were administered to the study target population and out of the number, 65 questionnaires were completed and returned. This represents a general response rate of 74.71% that is in accordance with Orodho (2009) that a response rate above 50% contributes towards gathering of sufficient data that could be generalized across the target population. Kothari (2004) also contends that a response rate of 50% or more is adequate for a descriptive study.Thus sufficient data was gathered for analysis and generalization to establish the effect of lean manufacturing practices on supply chain performance of sugar manufacturing firms.

Descriptive Findings and Analysis

The study used mean and standard deviation descriptive statistics to capture the responses based on the various indicators of study variables on a Likert scale of 1-5 (5= Very Large Extent; 4 =Large Extent; 3= Moderate Extent; 2= Low Extent and 1= Very Low Extent). This

section therefore presents the average responses on each of the variables whereas the standard deviation indicates the magnitude of variations in the responses.

Extent of adoption of Just-In-Timeproduction among Sugar Manufacturing Firms

The respondents rated various statements on Just in Time Productionon the rating of 1-5 (5= Very Large Extent; 4 =Large Extent; 3= Moderate Extent; 2= Low Extent and 1= Very Low Extent). The average responses as shown on Table 3 show that majority of the respondents agreed that the company avails labor on demand in order to manage labor costs (mean = 4.08). A standard deviation value of 0.94 was an indication that the responses provided on the statement regarding availability of labor on demand for the purpose of managing costs was not highly varied among the respondents. Majority of the participants of the study also agreed that their company avails resources on demand in order to manage wastage (mean = 4.29) where a standard deviation of 1.14 denotes that the responses provided on this statement were not highly varied. The results further showed that majority of respondents agreed that the company produces on demand in order to manage inventory costs (mean= 4.03)while majority also agreed that the company orders raw materials from the suppliers only when there is demand for production from customers (mean= 4.12).

On the same note, majority of the respondents agreed that the company has simplified production design to ensure timely production (mean= 3.85). A standard deviation value of 1.29 was an indication that the responses provided on the statement regarding simplification of production design to ensure timely production was not highly varied among the respondents. Similarly, the results of the study showed that majority of the respondents agreed that the company has multiple skill workers to ensure faster production on time (mean =3.85) and has a daily schedule commitment to ensure fasterproduction on time (mean =4.15).

Table 3: Extent of adoption of Just-In-Time production among Sugar Manufacturing Firms

Statement	Mean	Standard Deviation
The company avails resources on demand in order to manage wastage	4.29	1.14
The company has a daily schedule commitment to ensure faster production on time	4.15	0.87
The company orders raw materials from the suppliers only when there is demand for production from customers	4.12	1.07
The company avails labor on demand in order to manage labor costs	4.08	0.94
The company produces on demand in order to manage inventory costs	4.03	0.97
The company has simplified production design to ensure timely production	3.85	1.29
The company has multiple skill workers to ensure faster production on time	3.85	1.30
Average	**4.05**	**1.08**

Extent of adoption of Total Quality Control among Sugar Manufacturing Firms

The respondents rated various statements on Total Quality Control on the rating of 1-5 (5= Very Large Extent; 4 =Large Extent; 3= Moderate Extent; 2= Low Extent and 1= Very Low Extent). As indicated on Table 4, majority of the respondents agreed that the firm has manageable defect prevention costs related to quality planning (mean= 4.28). A standard deviation value of 0.80 implies that the responses provided were not highly varied among the respondents. On the same note, majority agreed that the company has manageable defect prevention costs related to investment in quality related information systems (mean=4.32), has manageable appraisal costs related to test and inspection of purchased materials (mean =4.42) and quality audits (mean =3.57).

The findings indicated that the companies have manageable internal failure costs related to reworks (Mean=3.85) with a standard deviation of 1.08 implying that the responses provided did not vary highly among respondents. Similarly, majority of the respondents involved in the study agreed that the company has manageable internal failure costs related to scrap (mean =3.95) and that the company has manageable external failure costs related to complains in and out of warranty (mean = 4.58). On average, majority of the respondents agreed that the company employs total quality control practices with a standard deviation value of 0.92 an indication that the responses were not highly among respondents.

Table 4 Extent of adoption of Total Quality Control among Sugar Manufacturing Firms

Statement	Mean	Standard Deviation
The company has manageable external failure costs related to complains in and out of warranty	4.58	0.53
The company has manageable appraisal costs related to test and inspection of purchased materials	4.42	0.86
The company has manageable defect prevention costs related to investment in quality related information systems	4.32	0.87
The company has manageable defect prevention costs related to quality planning	4.28	0.80
The company has manageable internal failure costs related to scrap	3.95	0.98
The company has manageable internal failure costs related to reworks	3.85	1.08
The company has manageable appraisal costs related to quality audits	3.57	1.33
Average	**4.14**	**0.92**

Status of Supply Chain Performance of Sugar Manufacturing Firms

The respondents were also required to rate statements on the dependent variable (supply chain performance)on a five point Likert scale ranging from 1-5 (5= Very Large Extent; 4 =Large Extent; 3= Moderate Extent; 2= Low Extent and 1= Very Low Extent). Based on their response, means and standard deviations were obtained and presented in Table 5. From the results of the study, majority of the respondents agreed that application of lean production

practices has reduced the supply chain costs (mean= 4.15) and that use of lean production practices has improved the quality of products (mean =4.48). On the same note, majority of the respondents agreed that application of lean production practices has reduced the supply chain order to delivery lead time (mean = 4.66) with a standard deviation value of 0.57 an indication that the responses provided did not vary highly among the respondents.

The findings of the study also showed that majority of the respondents agreed that application of lean production practices has led to improved flexibility in production (mean 3.49). Application of lean production practices has also led to improved resource utilization according to majority of respondents who agreed (mean =3.80). The results further showed that majority agreed that application of lean production practices has led to improved supply chain response time (mean =3.77). In addition, the findings indicated that majority agreed that application of lean production practices improved the firm's delivery performance (mean =4.58). A standard deviation value of 0.5 was an indication that the responses provided on the statement regarding application of lean production practices to improve the firm's delivery performance were not highly varied among the respondents. On average, majority agreed that the firm applied various lean production practices that improved supply chain performance (mean =4.13). A standard deviation value of 0.86 implied responses provided on use of lean production practices to improve supply chain performance were not highly varied.

Table 5 Status of Supply Chain Performance of Sugar Manufacturing Firms

Statement	Mean	Standard Deviation
Application of lean production practices has reduced the supply chain order to delivery lead time	4.66	0.57
Application of lean production practices improved the firm's delivery performance	4.58	0.50
Application of lean production practices has improved the quality of products	4.48	0.50
Application of lean production practices has reduced the supply chain costs	4.15	0.81
Application of lean production practices has led to improved resource utilization	3.80	1.12
Application of lean production practices has led to improved supply chain response time	3.77	1.01
Application of lean production practices has led to improved flexibility in production	3.49	1.48
Average	**4.13**	**0.86**

Regression Model Diagnostic Tests

The study conducted diagnostic tests before using an ordinary least square regression model to test the study hypotheses. This was also to ensure that assumptions of classical regressions are not violated. The normality test, linearity test, tests of homoscedasticity as well as multicollinearity were conducted before running the respective regression models. These tests have been described in the subsection.

Normality Test

For the purpose of testing the normality of the data, the study used Shapiro–Wilk and K-S test to detect deviation from normality due to skewness or kurtosis (Mangeni & Mike, 2018). The statistic in Shapiro–Wilk test ranges between -0.1 to +1.0 and the data is normal when the figures are higher than 0.05 (Razali & Wah, 2011). Additionally, the K-S statistic was not significant. Accordingly, if the statistic is greater than 0.05, it implies that data is normally distributed as the null hypotheses is not rejected. The findings as presented in Table 6 show that supply chain performance of sugar manufacturing firms(dependent variable) was normally distributed since its significance value (0.063) is greater than 0.05.

Table 6 Normality Test

	Kolmogorov-Smirnova			**Shapiro-Wilk**		
	Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Supply Chain Performance	0.15	65	0.072	0.937	65	0.063
Lilliefors Significance Correction						

Multicollinearity Test

A regression analysis was conducted and the tolerance and Variance Inflation Factors (VIF) extracted for the purpose of establishing whether there was multicollinearity among predictor variables. According to Field (2009), VIF values of less than 10 denotes absence of multicollinearity which can also be confirmed by Tolerance values of above 0.1. In accordance with Field (2009) recommendations, the results as shown in Table 7 show that all the variables had VIF value of less than 10 indicating that the there was no problem of multicollinearity. On the same note, Tolerance values were above 0.1 which further confirmed that there was no multicollinearity among the variables of the study.

Table 7 Variance Inflation Factor Test of Multicollinearity

	Collinearity Statistics	
	Tolerance	**VIF**
Just in Time Production	0.667	1.500
Total Quality Control	0.686	1.459
Dependent Variable: Supply Chain Performance		

Homoscedasticity Test

One of the critical assumptions of using linear regression model is that the error term (residual) is constant among the independent variables. This study therefore conducted the Breusch-Pagan test as recommended by Warner (2008) to check for homogeneity of the error term among the independent variables. The Breusch-Pagan test states that the probability value should be greater than .05 to meet the homoscedasticity assumption (Mangeni, 2018). The null hypothesis of constant variance is not rejected when the significance (Prob > Chi^2) value is greater than .05 (Warner, 2008). As shown inTable 8the significance (Prob > Chi^2) value was 0.0534 which is greater than .05 and hence the null hypothesis of Homoscedasticity was not rejected.

Table 8 Homoscedasticity Test

Breusch-Pagan / Cook-Weisberg test for Heteroskedasticity	
Variables: fitted values of Supply Chain Performance	
$Chi^2(1)$	4.52
Prob > Chi^2	0.053

Autocorrelation Test

Autocorrelation test was conducted to ensure that the error term is not correlated. One of the assumptions of using an ordinary least square regression model is that the error term shouldnot be correlated. To establish for this problem, Durbin Watson test was adopted. The results as presented in Table 9indicated that the error term was not auto correlated since DW statistic was 1.566 which is within the range of 1.5 and 2 (Flick,2015).

Table 9 Durbin Watson Test

Durbin Watson Statistic	1.566

Regression Model ofLean Manufacturing Practices and Supply Chain Performance

The study ran an overall ordinary least square regression model to establish the relationship between the study variables. The model summary results as presented in Table 10showed that the 2 lean manufacturing practices of Just in Timeand Total Quality Controljointly had a strong positive influence on supply chain performance of sugar manufacturing firms in Western Kenya. The model summary results in Table 10shows that R-square was 0.686denotingJust in Timeand Total Quality Control account for 68.6% of the variation in supply chain performance of the firms. The value of 0.686 shows that the model provides a good fit (Kumar, 2015).

Table 10 Model Summary

R	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
.829	0.686	0.666	0.19113
Predictors: (Constant), Total Quality Control, Just In Time Production			

In order to establish the significance of the regression model used, ANOVA test results in Table 11was used. The P-value = 0.000 was less than 0.05 and the study interprets this to mean that themodel predicted by Lean Manufacturing Practices was having a significant relationship with supply chain performance. The model significance confirms the suitability of lean manufacturing practicesin predicting the aberration of supply chain performance of sugar manufacturing firms.

Table 11 ANOVA (Model Significance)

	Sum of Squares	df	Mean Square	F	Sig.
Regression	4.798	2	2.399	32.836	.000
Residual	2.192	62	0.0353		
Total	6.99	64			
Dependent Variable: Supply Chain Performance					
Predictors: (Constant), Total Quality Control, Just In Time Production					

The regression model coefficients are presented in Table 12. The results indicated that Just in Time production has a positive and significant effect on supply chain performance (Beta = .308, Sig = .000, < .05). This implies that increasing Just in Time production practices by one unit leads to a significant increase in supply chain performance of sugar manufacturing firms by .308 units. The results also indicated thattotal quality control has a positive and significant effect on supply chain performance of sugar manufacturing firms in Western Kenya (Beta = .196, Sig = .011, < .05). This implies that increasing total quality control by one unit leads to a significant increase in supply chain performance of the firms by .196 units.This implies that an improvement in both just in time and total quality control practices among these firms was associated with an improvement in supply chain performance. Related findings were shown by Tripathi and Tiwari (2016); Sayid (2017); Fatuma (2015) and Chang (2009).

Table 12 Model Coefficients

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	0.641	0.317		2.023	0.048
Just In Time Production	0.308	0.068	0.404	4.561	0.000
Total Quality Control	0.196	0.074	0.23	2.633	0.011
Dependent Variable: Supply Chain Performance					

CONCLUSIONS

The study concluded that there is a positive and significant association between just in time production practices and supply chain performance. This means that an increase in just in time production practices results to a significant improvement in supply chain performance. In order of importance, availing resources on demand in order to manage wastage, daily schedule commitment to ensure faster production on time, ordering raw materials from the suppliers only when there is demand for production from customers, availing labor on demand in order to manage labor costs, producing on demand in order to manage inventory costs, simplifying production design to ensure timely production and having multiple skill workers to ensure faster production on time.

The study further concluded that that there is a positive and significant association between total quality control and supply chain performance. This implies that an increase in total quality control results to a significant improvement in supply chain performance. The most important total quality control practices in order of importance are having manageable external failure costs related to complaints in and out of warranty, appraisal costs related to

test and inspection of purchased materials, defect prevention costs related to investment in quality related information systems, defect prevention costs related to quality planning, internal failure costs related to scrap, internal failure costs related to reworks and appraisal costs related to quality audits.

RECOMMENDATIONS

The study recommends that for the purpose of improving supply chain performance, sugar manufacturing firms in the western region of Kenya should consider the use of just in time production practices such as availing labor on demand in order to manage labor costs, availing resources on demand in order to manage wastage, production on demand in order to manage inventory costs, ordering raw materials from the suppliers only when there is demand for production from customers, having a simplified production design to ensure timely production and having multiple skilled workers to ensure faster production as these practices significantly increase supply chain performance of the firms.

In addition, in order for the sugar manufacturing firms to increase supply chain performance, there is need to adopt total quality control practices such as having manageable defect prevention costs related to quality planning, putting in place manageable defect prevention costs related to investment in quality related information systems, having manageable appraisal costs related to test and inspection of purchased materials, having manageable appraisal costs related to quality audits, having controllable internal failure costs related to reworks and having manageable internal failure costs related to scrap.

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