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Effect of Lean Manufacturing on Operational Performance of Sugar Firms in Kenya

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ABSTRACT: *Lean manufacturing, by minimizing waste and optimizing processes, has the capability to improve operational performance and boost efficiency within Sugar Firms as a survival and growth strategy. The Sugar Firms in Kenya contribute approximately 26% directly to the Gross Domestic Product (GDP) and an additional 25% indirectly through agro-based and associated industries linkages. However, they have experienced a significant decline of milled sugar production from about 635,700 tonnes in 2015 to 491,100 tonnes in 2018 according to Kenya National Bureau of Statistics in 2019. This decline was mainly attributed to the high cost of production stemming from inefficiencies across the value chain from inadequate research and extension leading to the design of production systems that are inefficient. Despite the vast contribution of the Sugar Firms to the economy, this problem of inefficient production system has not been solved and thus the Sugar Firms performance continues to spiral downward leading to the dissolution of some firms, downscaling of operations etc. The studies reviewed also, established a weak relationship between lean manufacturing and operational performance warranting investigation. It is in this regard that this study purposes to establish the effect of lean manufacturing on operational performance of Sugar Firms in Kenya. The research was guided by the resource-based view theory and transaction cost theory. A census survey was conducted targeting all 164 managers and assistant managers of Sugar Firms in Kenya. A pilot study was conducted of 14 participants constituting of managers and assistant managers of seven departments in Transmara Sugar Company to test for reliability using Cronbach's alpha, with a threshold of 0.70, indicating satisfactory instrument reliability. The Cronbach's Alpha reliability coefficient obtained in this study was 0.849. Primary data was collected using questionnaires. A multiple linear regression model was applied to establish the association among explanatory variables in this study. The results established that lean Manufacturing had a significant positive effect on operational performance (β=0.661, p=0.000), suggesting that the implementation of lean manufacturing practices leads to 0.661 unit increase in operational performance. Hence, the study offers a lean manufacturing model that can assist in enhancing operational performance.*

KEY WORD*: Lean Manufacturing and operational performance*

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I. INTRODUCTION

With the advent of limited raw materials, Toyota began to adopt LM practices so as to lower the cost of production and to advance a variety of manufactured models which in return would better place them in the global market (Kiran, 2022). Lean manufacturing is a production technique that prioritizes removing inefficiencies and strives for continuous improvement to achieve higher efficiency levels and cost savings by eliminating waste (Kumar *et al.*, 2022). Johan& Soediantono, (2022) lean manufacturing has extensively been adopted in diverse industries to enhance to improve productivity, reduce lead time, enhance customer satisfaction, and advance the company's competitiveness. Palange & Dhatrak, (2021) also postulated that companies utilizing lean manufacturing practices enjoy an efficient supply chain, increased productivity,

reduced production costs & involvement of personnel, reduced inventory, and advanced response to production breakdown.

Lean manufacturing is defined as a logically organized production system with the intent of identifying and eliminating waste by practicing routine and continuous improvement with the aim of adopting a smooth supply chain (Silva, 2012). Waste is anything that is not adding value to any activity (Suhardi *et al*., 2019). Womack & Jones, (2003) established eight types of waste: motion, correction waste, unnecessary transportation waste, waiting waste, knowledge waste, inventory waste, over-processing waste, and overproduction waste. Rocha-Lona *et al*., (2013) established four main lean manufacturing practices in use today; total product maintenance (TPM), just-in-time (JIT), continuous improvement (CI), and value stream mapping (VSM).

Universally many companies are focused on the adoption of practices that are oriented to eliminate waste from their operations management activities to elevate their production systems Santibanez Gonzalez *et al*., (2019) but they cannot fully manage the dynamic product designs which are evolving over time (Shivankar & Deivanathan, 2021). In order for firms to effectively utilize operations management practices, they should focus on reviewing their product designs from time to time (Roble & Wanjira, 2021). Product design is the backbone of all operations in an organization (Chary, 2012). Product *design not only* affects *operational performance but also* determines the components constituting a *product* and defines their makeup to yield the desired output by functioning as a union (Naderi *et al*., 2020). In view of this product design is gaining robust momentum among companies as a survival and growth strategy(Bagshaw, 2017). However, due to limited resources and waste in the production systems, though not significant product designs must be treated with care, to ensure efficiency in the production line for a company to be on the competitive edge. The current production landscape in companies is therefore guided by the implementation of lean manufacturing principles in respective operations, so as to minimize waste in the production lines for them to ensure minimized production cost, production efficiency and to be competitive universally. Product design, lean manufacturing and operational performance are therefore a union for efficiency in any production (Basu *et al*., 2021; Pullan *et al*., 2013; Susilawati *et al*., 2015)

Lean manufacturing discipline is gaining robust momentum among manufacturing firms (Abolhassani *et al.*, 2016). This is because adoption of LM leads to significant increase in the operational performance of the firm at the expense of minimized waste in the production system (Shi *et al*., 2019). As a result, the adoption of lean manufacturing practices by manufacturing firms is encouraged because it elevates them against their competitors by rationalizing their production systems (Zahraee *et al*., 2020). Similarly, Lazai *et al*., (2020) established that applying lean manufacturing principles has a big impact on a company's success as it reviews its production process by ensuring efficiency and reducing the cost of production. Besides that Lean manufacturing is oriented toward meeting customer demands by manufacturing of products and services with optimal cost efficiency, in regard to the evolving customer demands (Bhamu & Sangwan, 2014).

Previously reviewed research examining the correlation between LM and operational performance remains inadequate. Similar to studies conducted prior, this study was looking at determining the correlation between LM and operational performance. For instance, prior review studies, Hernandez-Matias *et al*., (2019) establishing Lean manufacturing and operational performance focused on lean production managers and front-line supervisors of 202 Spanish companies in Spain concentrated on interconnectedness between human-related lean practices. Seng *et al*., (2021) while studying the industry 4.0 and lean manufacturing practices: an approach to enhance operational performance in Singapore's manufacturing sector with a total of 51 companies sampled giving attention to the integration of lean and industry relation 4.0. Nawanir, (2016) while studying the effect of lean manufacturing on operations performance and business performance in manufacturing companies in Indonesia involving 174 large manufacturing companies focused on the functions of lean manufacturing (LM). Besides that, Malonza, (2014) employed the theory of constraints to explore the effect of lean manufacturing on operational performance of Mumias Sugar Company Limited, Kenya only focused on lean manufacturing tools.

Based on the reviewed studies above, lean manufacturing influence on operational performance, basically they concentrated on the general aspect of lean manufacturing tools and the perspective of the manufacturing system. As a result, they were not able to establish the best practices to be adopted in a manufacturing system and how they can be adopted to boost operational performance of the companies under study. This study adopted the four LM principles (JIT, TPM, VSM, and (CI)) proposed by (Rocha-Lona *et al*., 2013). Similarly, in attempts to determine lean manufacturing's influence on operational performance, they adopted unexclusive metrics of operational performance by focusing on only the effect of the interests of stakeholders rather than the firm's operational performance as an overall primary purpose of existence of a company.

So as to solve such, majority of studies in this area (Everaert & Swenson, 2014; Kropivšek *et al*., 2021; Tornberg *et al*., 2002; Wedowati *et al*., 2020) have opted on adopting activity-based costing protested by Balakrishnan *et al*., (2015) who disputed that it is resource intensive and time-consuming making them unable to address the issue of short time delivery and limited utilization of resources in the product line guided by the

product design. This implies that it does not take into account the wastes in the manufacturing system during the transformation process. Hence, wastes in the manufacturing system may not be realized and mitigated during production hence jeopardizing the application of principles of lean manufacturing.

Wastes in the production line can lead to tangible and adverse effects on a company's operational performance (Alkhoraif & McLaughlin, 2018; Basu *et al*., 2021; Bhamu & Sangwan, 2014). Since product design is focused on the review or development of production lines it was of great impact once incorporated with lean manufacturing to eliminate waste. Besides that Abdillah & Puspita, (2022) product design has no positive significant effect on purchasing decisions, while, Rincon-Guevara *et al*., (2020) established that there is a positive association between product design on manufacturing system operations. Hence, there is a need for the adoption of lean manufacturing as a moderate to address such mixed results and weak relations between product design and operational performance.

The sugar sub-sector contributes about 26% to the GDP and an additional 25% to the agro-based and related industries according to the Sugar Sub-Sector Strategic Plan 2021-2025 established by (Kenya Association of Manufacturers, 2021). Agricultural production is the major economic subsector in Kenya with Sugar production being the key industry (KIPPRA, 2018). Kenya Association of Manufacturers, (2020) also established that sugar sub-sector in Kenya is key in the both country's agricultural sector and economy with the potential to contribute to regional development, employment creation, food security, and improved livelihoods for more than eight million Kenyans. However, Kenya National Bureau of Statistics, (2019) survey demonstrates that Kenya has experienced a significant decline in milled sugar production from about 635,700 tonnes in 2015 to 491,100 tonnes in 2018. Similar findings were registered in the sugar sub-sector report by Kenya Association of Manufacturers, (2020) production of sugar in Kenya has gradually declined, from 523,652 metric tones in 2010 to 440,935 metric tones in 2019. Kenya Association of Manufacturers, (2020)Strategic Plan 2021-2025, this is due to many challenges facing the sugar sub-sector including: high cost of production, inefficiencies across the value chain, obsolete technology, inadequate research and extension, and policy limitations. As a result, sugar importation has been increasing rapidly for the periods under review (2014,2015,2016,2017and 2018) 192.1, 227.4, 334.1, 989.6, 284.2 tones respectively (Kenya National Bureau of Statistics, 2019). This is due to the increased cost of production as established by the (Kenya National Assembly Eleventh Parliament, 2015). Also, Miwani Sugar, Muhoroni and Mumias companies have been put under receivership with Ramisi and Soin closing their operations (Kenya Association of Manufacturers, 2020)

According to the Kenya National Assembly Eleventh Parliament, (2015) report on crisis facing the sugar industry it recommended for privatization of all government-owned sugar firms in order to transform the industry into self-sustain. Miwani Sugar, Muhoroni, and Mumias companies are under receivership as indicated by (Kenya Association of Manufacturers, 2020), and the challenges faced by the sugar sub-sector include: high cost of production, inefficiencies across the value chain, obsolete technology, inadequate research, and extension and policy limitations. Kenya Association of Manufacturers, (2020).

From the reviewed literature Kenya produces sugar at a relatively high cost, which is mostly due to incapacitation in the value chain. This not only makes the Kenyan market less competitive but also makes it a desirable destination for imports both locally and internationally Due to the reduced sugar prices caused by imports from low-cost manufacturers from other countries, local mills are unable to sell the locally produced sugar to the market at the necessary margin. Unprecedented difficulties in the sugar sector have had a significant impact on cane and sugar production. The key issues affecting the sugar subsector include, among others, high production costs, inefficiencies along the entire value chain, low productivity, severe cane shortage, weak extension support, unregulated and illegal sugar imports, weak regulatory environment, high levels of debt, lack of value-adding initiatives, poor governance, cyclical markets, outdated machinery, slow payments to cane farmers, inadequate research and extension and policy limitations. Hence, this establishes the foundation for this research in the development of a robust model of interaction among product design, LM, and operational performance practices so as to lower the cost of production, address inefficiencies across the value chain, elevate its technology and transform the sector´s policy formulation.

1.1 Research Objective

The following research objective was constituted in the study:

i. To evaluate the effect of lean manufacturing practices on operational performance of Sugar Firms in Kenya.

1.2 Research Hypotheses

$H_{o1.}$ Lean manufacturing practices have no significant effect on operational performance of Sugar Firms in Kenya.

II. LITERATURE REVIEW

2.1 Lean Manufacturing and Operational Performance

Hernandez-Matias *et al*., (2019) carried out a study on lean manufacturing and operational performance interrelationships between human-related lean practices focusing on lean production managers and frontline supervisors of 202 Spanish companies in Spain. They established that lean manufacturing helps managers to establish a pattern that a firm may adopt in human-related lean practices to positively implement LM so as to boost operational performance. The research was based on a mixed research design. However, the study adopted web surveys which are prone to survey fraud being the key weakness of online surveys, hence culminating in biased conclusions. Also, they did not adopt lean manufacturing indicators like continuous improvement, Just-in-Time, total productive maintenance, and value stream mapping to measure it instead it was limited to applied human-related lean practices. Finally, the study also was entirely based on human-related lean practices and did not review the production system which is a key unit of interest in matters of lean manufacturing.

Seng *et al*., (2021) while studying Industry 4.0 and lean manufacturing practices: an approach to enhance operational performance in Singapore's manufacturing sector. A total of 51 companies were sampled giving attention to the integration of lean and industry relation 4.0. A positive association was established by the research between LM and operational performance. However, the study adopted a survey method that does not encourage respondents to provide accurate, honest judgment.

Nawanir, (2016) while studying the effect of lean manufacturing on operations performance and business performance in manufacturing companies in Indonesia involving 174 large manufacturing companies focused on the functions of LM. The research concluded that lean manufacturing practices are significantly associated and they are interdepend. Besides that, study outcomes indicated that lean manufacturing practices ought to be adopted holistically, as they jointly support and supplement each other. Also, the study established that Lean manufacturing is positively correlated with a firm's operational performance. The study adopted a purposeful sampling technique. However, it is not appropriate for gathering data from a large population and hence may result in sampling biasness and invalid research outcomes.

Malonza, (2014)employed the theory of Constraints to explore the effect of lean manufacturing on operational performance of Mumias Sugar Company Limited, Kenya. The study adopted descriptive approach and utilized a case study centered on Mumias Sugar.The study indicated a notable correlation between LM and operational performance. It also indicated that implementation of lean manufacturing practices may result to: improved standardization of processes, improved efficiencies, and housekeeping of plant. The case study applied for this study was very relatively small hence the research outcome acquired might not be appropriate to be generalized.

Kunyoria, (2018) conduct a study on the effect of lean manufacturing on organizational performance: a case of South Nyanza Sugar Company, Awendo Kenya. The study adopted a correlational research design. The study sampled 78 respondents from different departments in the Sugar Company, Awendo Kenya using a stratified random sampling method. Based on the findings, the indicators of lean manufacturing were based on technology adoption, intellectual knowledge, and elimination of waste. The study indicated a notable correlation between LM and organizational performance. However, the case study was too small to be used for the purpose of generalization.

Buer *et al.,* (2021) conducted a study to assess the complementary effect of lean manufacturing and digitalization on operational performance in Norway. The study conducted an online survey from a sample of 212 Norwegian manufacturing companies and recoded 76 responses from the online survey. The findings revealed that for manufacturing firms to fully benefit from new technologies and turn them into better operational performance, lean manufacturing remains pertinent rather a more significant strategy to adopt. However, the study adopted an online survey which is prone to non-response bias, as survey fraud is eminent when conducting online surveys. The respondent margin was very small compared to the sample population, hence may prevent the findings from being extrapolated.

Nawanir, (2016) carried out a study on the effect of lean manufacturing on operations performance and business performance in manufacturing companies In Indonesia. The study adopted a mail-based survey to collect data from 1000 respondents. The study established that lean manufacturing is positively associated with operations performance and business performance. The study, however, adopted an online survey which is prone to non-response bias, as survey fraud is eminent when conducting online surveys. The study did not utilize: value stream mapping, continuous improvement, total productive maintenance and Just-in-Time which are the main principles to measure lean manufacturing.

Hernandez-Matias *et al*., (2019); Seng *et al*., (2021); Nawanir, (2016); Malonza, (2014); Kunyoria, (2018); Buer *et al.,* (2021); and Nawanir, (2016) conducted studies to examine the effect of lean manufacturing on operational performance. Their finding postulates that lean manufacturing was positively association linked to operational performance. However, Hernandez-Matias *et al*., (2019); Buer *et al.,* (2021); and Nawanir, (2016) in their studies they adopted web surveys which may culminate in biased conclusions. Seng *et al*., (2021) in

their study to investigate industry 4.0 and lean manufacturing practices: an approach to enhance operational performance in Singapore's manufacturing sector adopted a survey method that does not encourage respondents to provide accurate, honest judgment. Malonza, (2014)&Kunyoria, (2018)conducted their studies on the effect of lean manufacturing on operational performance of Mumias Sugar Company Limited, Kenya, and South Nyanza Sugar Company, Awendo Kenya respectively. However, the case study adopted for this study was relatively small hence the research outcome acquired might not be appropriate to be generalized. All the reviewed studies did not adopt principles of lean manufacturing (value stream mapping, continuous improvement, Just-in-Time, and total productive maintenance proposed by Rocha-Lona *et al*., (2013) which additionally will affect operational performance and determine its moderation effect on the association among product design and operational performance. Finally only two of the reviewed studies did take Sugar Subsector as a case study hence forming a basis for this study in this subsector.

It is worth noting that the prior research approaches have, further, been criticized. (Buer *et al*., 2021; Hernandez-Matias *et al*., 2019; Nawanir, 2016) utilized web surveys, which might introduce bias and affect the accuracy of their conclusions. Buer *et al*., (2021) study result ($\beta = 0.444$, $p = 0.005$) demonstrated significance, but the higher p-value suggests a slightly less confident level of significance. Similarly, Seng *et al*., (2021) study results (R square is 0.644, Durbin-Watson is 2.312) provided an R-squared value that indicated meaningful explained variance but did not offer insight into the statistical significance of the relationship. Moreover, the studies conducted by (Kunyoria, 2018; Malonza, 2014)focusing on Mumias Sugar Company Limited, Kenya, and South Nyanza Sugar Company, Awendo Kenya, respectively, used relatively small case studies. Consequently, the outcomes might not be readily applicable to other contexts, limiting the generalizability of their findings. Moreover, (Kunyoria, 2018) study result ($\beta=0.672$, $p = 0.037$) indicates a significant relationship as well, but the proximity of the p-value to the significance threshold suggests a slightly weaker level of confidence.

Furthermore, none of the reviewed studies incorporated all the following essential lean manufacturing practices to constitute a cohort metric to measure LM e-manufacturing proposed by Reid & Sanders, (2013) supply chain management and quality function deployment proposed by Heizer *et al*., (2017); and digital technologies proposed by Sayar & Er, (2019). This oversight could have influenced the impact of lean manufacturing on operational performance in those studies. Finally, only two of the reviewed studies Malonza, (2014)&Kunyoria, (2018) did take Sugar Subsector as a case study hence forming a basis for this study in this subsector.

III. RESEARCH METHODOLOGY

This study was guided by a correlational research design. Creswell, (2015) postulated that correlational research design as the use of statistical tests to establish the pattern or tendency between two (or more) variables or sets of data to vary consistently. The positivism research philosophy served as the study's guiding philosophy. This is because the positivism research philosophy is of the understanding that factual knowledge is attained via observation (the senses), as well as measurement is trustworthy (Saunders *et al*., 2009). Verhaegh, (2020) the positivist model proclaims that real phenomena can be pragmatic empirically and substantiated by logical analysis. Positivism research philosophy expresses that reality is stable. Positivism applies hypothetico-deductive method to determine priori hypotheses quantitatively and functional associations may be consequential among causal and explanatory factors (independent variables) and outcomes (dependent variables) (Jacobs & Chase, 2008).

The research was conducted within the context of Sugar Milling Companies in Kenya, encompassing: Muhoroni Sugar Company, Chemelil Sugar Company, Mumias Sugar Company, Nzoia Sugar Company, Sony Sugar Company, Miwani Sugar Company, Ramisi Sugar, West Kenya Sugar Company, Soin Sugar Company, Kibos Sugar & Allied Industries Limited, Butali Sugar Mill limited, Transmara Sugar Company, Sukari Sugar Company, Kwale International Sugar Company, Ole Pito Sugar Company, and Busia Sugar Company. The study was based on western Kenya Sugar Companies. Western Kenya Sugar Firms was selected because according to Kenya Association of Manufacturers, (2020) it has 75% of Sugar Firms.

The sample population was 164 respondents which constituted all 84 departmental managers and 84 assistant managers of the Sugar Firms in Kenya as indicated in appendix v. The choice for managers and assistant managers was based on their direct engagement with systems and active participation in implementing functional practices make them well-suited sources for capturing accurate and comprehensive data, aligning with the study's objective of exploring the association between manufacturing activities and operational performance. The study used a census survey as a guide for data collection from 164 sugar firms' employees in Kenya. A census survey was suitable for this study because it is applied when all the units of observation in a study are considered and they are of a small sample size (Kothari, 2004).

Primary data was collected using questionnaires from employees of Sugar firms in Western Kenya (departmental managers and assistant managers).

The rates of response returns of employees from various Sugar Firms in Kenya are established in Table 1. Among the companies surveyed, Chemelil Sugar Company had a response return rate of 80.0%, Nzoia Sugar Company attained 81.8% response return rate, Sony Sugar Company had 77.8% response return rate, Butali Sugar Mills Limited had 83.3% response return rate, with Sukari Sugar Company having a response return rate of 94.4%, Kibos Sugar & Allied Industries Limited having a response return rate of 83.3%, West Kenya Sugar Company having a response return rate of 87.5%, Ole Pito Sugar Company having a response return rate of 81.3% and Busia Sugar Company exhibited a rate of response return of 77.8%. The grand total rate of response was recorded at 82.9%. which conforms to (Ary *et al.*, 1996; Fowler Jr, 1993) who postulated that a minimum response return of 75% is significant.

Table 1: Response Return Rate

Sugar Firm	Proposed Sample	Response return rate (%)
Chemelil Sugar Company	20	16(80.0)
Nzoia Sugar Company	22	18(81.8)
Sony Sugar Company	18	14(77.8)
Butali Sugar Mills Limited	18	15(83.3)
Sukari Sugar Company	18	17(94.4)
Kibos Sugar & Allied Industries Limited	18	15(83.3)
West Kenya Sugar Company	16	14(87.5)
Ole Pito Sugar Company	16	13(81.3)
Busia Sugar Company	18	14(77.8)
Grand total	**164**	136(82.9)

Source: Survey data, (2023)

3.2 Model Specification

This study modified and adopted a multiple linear regression model reviewed by Fairchild & MacKinnon, (2009) to establish the simultaneous effect of lean manufacturing on operational performance as illustrated below:

$Y=\beta_0+\beta_1 Z_{ij}+\varepsilon_0$…….. (3.4)

Y denotes operational performance, and Z signifies lean manufacturing practices.

$Y_{ij}= \beta_0+\beta_1 Z_{ij} +\varepsilon_i$…… (3.5)

Y_i= Operational performance

i =1, 2, 3, 4, 5 and Y_1= Speed of production, Y_2 is Product quality, Y_3 is Production flexibility, Y_4 is Product dependability, Y_5 is Production cost

Z_j= Lean Manufacturing practices

β_2 = Magnitude of the causal impact of Z, as indicated by the coefficient of lean manufacturing practices.

ε_i = Refers to the residual within the equation.

j ranges from 1 to 136

IV. RESULTS AND DISCUSSION

4.1 Effect of lean manufacturing practices on operational performance of Sugar Firms in Kenya

The second objective of the research was to evaluate the effect of lean manufacturing practices and operational performance of Sugar Firms in Kenya. To accomplish this goal, the initial step involved establishing the measurement of lean manufacturing, which was subsequently followed by testing the study's hypothesis. In pursuit of this objective, the following sub-indicators were used to measure lean manufacturing: continuous improvement, total productive maintenance, just-in-Time, and value stream mapping. The outcomes are depicted in Table 2 using frequency counts, percentages, means, and standard deviations. Responses were assessed using a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree).

Table 2: Lean Manufacturing

Statement	SD f (%)	D f (%)	N f (%)	A f (%)	SA f (%)	MEAN	SD
Adoption of just-in-time has reduced manufacturing costs in my firm			15(11.0)	58(42.6)	63(46.3)	4.35	.673
Adoption of just-in-time has reduced the level of waste in my firm			26(19.1)	57(41.9)	53(39.0)	4.20	.739
Total productive maintenance has decreased the incidence of accidents in my firm		33(24.3)	20(14.7)	49(36.0)	34(25.0)	3.62	0.549
Total productive maintenance has made equipment operating conditions better in my firm			20(14.7)	56(41.2)	60(44.1)	4.29	.711

Statement	SD f (%)	D f (%)	N f (%)	A f (%)	SA f (%)	MEAN	SD
My firm utilizes continuous improvement to fostering a culture of efficiency, quality, and adaptability			22(16.2)	65(47.8)	49(36.0)	4.20	.697
My firm utilizes continuous improvement to drive operational excellence in its manufacturing system			18(13.2)	71(52.2)	47(34.6)	4.21	.660
My firm utilizes value stream mapping to establish waste-producing sections			18(13.2)	73(53.7)	44(32.4)	4.19	.652
value stream mapping facilitates formation for possible solutions to minimize and eliminate waste in my firm			16(11.8)	69(50.7)	51(37.5)	4.26	.655

Source: Survey Data (2023)

Table 1's outcomes have demonstrated a strong support among the respondents over the adoption of just-in-time in the reduction of manufacturing costs evident through the highest proportion, (46.3%) who strongly agreed with a mean score of 4.35, confirming the results. Also, the standard deviation (SD = 0. 673) suggests some variations in the responses from the participants. In addition, in the second statement adoption of just-in-time reduced the level of waste, majority of respondents expressed a positive rating for the statement 41.9% (agree) and the mean score stands at 4.20, validating the findings. Further, the results also unveiled that total productive maintenance decreased the incidence of accidents in the Sugar firms with 36.0% of respondents expressed agreement with this statement and the mean score stands at 3.62, validating the findings. Based on the perspectives of the respondents, it was observed that total productive maintenance has made equipment operating conditions better in the Sugar firms as established by 44.1% of the respondents who strongly agreed. Sugar firms use machines to detect waste and faults in the manufacturing system demonstrated a notable rating with a mean score of 4.20 and a significant response of 47.8% (agreed). This finding was closely aligned with Sugar Firms' use of machines to detect faults in the manufacturing system with 52.2% of respondents expressed agreement with this statement and the mean score stands at 4.21, validating the findings, as depicted in table 4.3. Besides that, 53.7% of the respondents were in agreement that sugar firms utilize value stream mapping to establish waste-producing sections, as indicated by a robust mean score of 4.16, which strongly supports the obtained outcomes. Finally, 50.7% of the respondents also were in agreement that value stream mapping facilitates the formation of possible solutions to minimize and eliminate waste in the sugar firms, with a mean score of 4.19, seconding the findings.

The findings from Table 2 demonstrated strong approval from the respondents regarding adoption of just-in-time for reducing production costs and waste, as well as the effectiveness of total productive maintenance in improving equipment operating conditions and reducing accidents in the Sugar firms. The results also highlight the significant use of machines for detecting waste and faults in the manufacturing system, along with the implementation of value stream mapping to identify and address waste-producing sections, providing valuable insights for improving operational efficiency and resource utilization in the sugar sector.

In pursuit of the research's second objective, the researcher examined a null hypothesis: "Lean manufacturing practices have no significant effect on the operational performance of Sugar Firms in Kenya." The relationship between the scores of lean manufacturing practices and operational performance was investigated using Pearson product-moment correlation, with overall mean being used as the starting point. In order to ascertain the presence of a correlation between lean manufacturing and operational performance, a Pearson product-moment correlation coefficient was performed. The decision to begin the research by conducting a Pearson correlation analysis was strategically chosen to establish an initial understanding of the relationships between variables, thereby providing a foundational framework for the subsequent ANOVA analysis (Zikmund & Babin, 2015). This approach allows for the exploration of potential associations among key factors, facilitating a more comprehensive and informed interpretation of the ANOVA results and contributing to a more robust overall analysis of the specific objective under investigation Meyers *et al*., (2016). Subsequently, a simple linear regression model was applied to regress how operational performance scores of related to lean manufacturing practices, aiming to determine the overall percentage change in operational performance attributed to implementation of lean manufacturing practices. The results of the correlation between lean manufacturing practices and operational performance are demonstrated in Table 3.

Table 3: Correlation between Lean Manufacturing Practices and Operational Performance Practices

Correlations

		Lean manufacturing	Operational Performance
Lean manufacturing	Pearson Correlation	1	.661**
	Sig. (2-tailed)		.000
	N	136	136
Operational Performance	Pearson Correlation	.661**	1
	Sig. (2-tailed)	.000	
	N	136	136

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Survey Data (2023)

Table 3 the results indicate that the Pearson product-moment correlation between lean manufacturing and operational performance exhibited a strong positive correlation that was statistically significant (r=0.661, p=0.000). As a result, the null hypothesis was rejected in favor of the alternative hypothesis, which suggests a positive and noteworthy connection between lean manufacturing and operational performance. This suggests that higher scores in lean manufacturing were associated with higher scores in operational performance for Sugar Firms in Kenya, indicating a substantial association amongst the two variables. To showcase this correlation, the Pearson product-moment correlation coefficient was employed, followed by the utilization of a simple linear regression model to evaluate the study's hypothesis. Before assessing the study's null hypothesis, the model's outcomes were initially examined to test its own null hypothesis. The null hypothesis of the regression model posits that "there is no significant association between any of the independent variables and the dependent variable within the population." This hypothesis is evaluated using the F-statistic obtained from the F distribution, commonly known as the F test.

In contrast, this current study stands out for its focus on the Sugar Subsector in Kenya, offering a valuable contribution to the existing knowledge. The established positive and noteworthy association between lean manufacturing and operational performance enhances and refines the resource-based view theory and transaction cost theory, which constituted a framework for this research. The findings underscore the importance of strategic resource allocation and efficient transaction management within the context of sugar firms in Kenya, providing valuable insights for the industry.Table 4 demonstrates the model's findings.

Table 4: Model Significance for the Relationship between Lean Manufacturing Practices and Operational Performance

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.837	1	2.837	103.836	.000[b]
	Residual	3.661	134	.027		
	Total	6.498	135			

a. Dependent Variable: Operational Performance

b. Predictors: (Constant), Lean Manufacturing

Source: Survey data, (2023)

The findings presented in Table 4 suggest that the model holds statistical significance at the 0.05 alpha level, with an F-statistic of 103.836 for degrees of freedom (1, 135). The F-statistic, with a value of 103.836, is a pivotal measure for assessing the overall significance of the regression model. In this specific context, the noteworthy F-value underscores that the inclusion of the predictor variable (lean manufacturing) significantly contributes to explaining the variance observed in the dependent variable (operational performance). A higher F-value strengthens the likelihood of a meaningful relationship between lean manufacturing and operational performance. This implies that the null hypothesis was rejected to uphold the alternative hypothesis, indicating a meaningful connection between the independent variable (lean manufacturing) and operational performance of the research subjects. Hence, the model is therefore deemed appropriate for evaluating the study hypothesis. Subsequently, the summary model for study hypothesis results were presented for justification if lean manufacturing practices had an effect on operational performance, as illustrated in Table 5.

Table 5: Summary Model for the Percentage change in Operational Performance Explained by Lean Manufacturing Practices

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.661[a]	.437	.432	.16529	.437	103.836	1	134	.000

a. Predictors: (Constant), Lean manufacturing

b. Dependent Variable: Operational Performance

Source: Survey data, (2023)

The outcomes presented in Table 5 reveal a significant coefficient of determination (R2 = 0.437, p = 0.000), indicating a positive connection between lean manufacturing practices and operational performance. This indicates that approximately 43.7% of the observed variability in operational performance can be accounted for by variations in the lean manufacturing. After correcting for any underestimation or overestimation of R2 outcomes, an adjusted R square value of 0.432 was determined (Adjusted R2 = 0.432, p = 0.000). To better understand the percentage change in operational performance explained by lean manufacturing practices, a value of 43.2% was obtained by multiplying the R square value by 100%.

The research analysis report provides compelling evidence to reject the null hypothesis which states that "Lean manufacturing practices have no significant effect on operational performance of Sugar Firms in Kenya." The findings demonstrate a significant coefficient of determination (R2 = 0.437, p = 0.000), indicating a strong and positive association between lean manufacturing practices and operational performance. The adjusted R square value of 0.432 further confirms this relationship after considering the potential underestimation or overestimation of the results.

The adjusted R square value of 0.432 translates to 43.2% when multiplied by 100%. This means that lean manufacturing practices alone can account for 43.2% of the variance in operational performance. Such a high percentage demonstrates that lean manufacturing practices have a noteworthy effect on the operational performance of Kenyan sugar firms.

Given these significant findings, the research analysis report supports the alternative hypothesis, suggesting that lean manufacturing practices do have a substantial influence on operational performance in the context of Sugar Firms in Kenya. Therefore, the investigation concludes that adopting lean manufacturing practices may result in enhanced operational performance in the Sugar Subsector, underscoring the importance of implementing these practices in the manufacturing system of Sugar Firms in Kenya. To gain further insights into the exceptional contribution of lean manufacturing on operational performance, additional results for the model coefficients were revealed in Table 6.

Table 6: Estimated Regression Coefficients for the relationship between Lean Manufacturing and Operational Performance

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
1	(Constant)	1.503	.264		5.701	.000			
	Lean manufacturing	.637	.063	.661	10.190	.000	.661	.661	.661

a. Dependent Variable: Operational Performance:

Source: Survey data, (2023)

It is apparent given the findings in Table 6, demonstrated that lean manufacturing is statistically significant and positively connected with operational performance (β = 0.661, p = 0.000). This implies that the null hypothesis was rejected to uphold the alternative hypothesis, indicating a meaningful connection between the independent variable (lean manufacturing) and operational performance. This suggests that when both lean

manufacturing and operational performance are standardized on the same scale and subjected to regression analysis, lean manufacturing shows a unique and impactful effect on operational performance.

The beta value of 0.661 indicates the extent by which operational performance scores would increase positively, equivalent to one standard deviation unit change in lean manufacturing practices. In practical terms, this means that when Sugar Firms in Kenya consistently implement and execute lean manufacturing practices, there will be a notable increase in operational performance. In conclusion, the study results demonstrate the importance of lean manufacturing practices in driving operational performance for Sugar Firms in Kenya. The significant relationship and positive beta value highlight the potential benefits of adopting and maintaining lean manufacturing principles to enhance overall operational efficiency.

The results of this investigation mirrored earlier studies conducted by (Buer *et al*., 2021; Hernandez-Matias *et al*., 2019; Kunyoria, 2018; Malonza, 2014; Nawanir, 2016, 2016; Seng *et al*., 2021) examined the association between lean manufacturing and operational performance. According to those studies, the concurrence was that lean manufacturing is statistically significant and positively connected with operational performance.

However, it is worth noting that the prior research approaches have been criticized. (Buer *et al*., 2021; Hernandez-Matias *et al*., 2019; Nawanir, 2016) utilized web surveys, which might introduce bias and affect the accuracy of their conclusions. Buer *et al*., (2021) study result ($\beta = 0.444$, $p = 0.005$) demonstrated significance, but the higher p-value suggests a slightly less confident level of significance. Similarly, Seng *et al*., (2021) study results (R square is 0.644, Durbin-Watson is 2.312) provided an R-squared value that indicated meaningful explained variance but did not offer insight into the statistical significance of the relationship. Moreover, the studies conducted by (Kunyoria, 2018; Malonza, 2014)focusing on Mumias Sugar Company Limited, Kenya, and South Nyanza Sugar Company, Awendo Kenya, respectively, used relatively small case studies. Consequently, the outcomes might not be readily applicable to other contexts, limiting the generalizability of their findings. Moreover, (Kunyoria, 2018) study result ($\beta=0.672$, $p = 0.037$) indicates a significant relationship as well, but the proximity of the p-value to the significance threshold suggests a slightly weaker level of confidence.

Furthermore, none of the reviewed studies incorporated all the following essential lean manufacturing practices to constitute a cohort metric to measure LM e-manufacturing proposed by Reid & Sanders, (2013) supply chain management and quality function deployment proposed by Heizer *et al*., (2017); and digital technologies proposed by Sayar & Er, (2019). This oversight could have influenced the effect of lean manufacturing on operational performance in those studies. Finally, only two of the reviewed studies Malonza, (2014)&Kunyoria, (2018) did take Sugar Subsector as a case study hence forming a basis for this study in this subsector. This study's findings make a valuable contribution to the existing knowledge and have the potential to enhance and refine the resource-based view theory and transaction cost theory, which served as the guiding frameworks for this research. By establishing a positive and significant association between lean manufacturing and operational performance, the research highlights the importance of strategic resource allocation and efficient transaction management within the context of sugar firms in Kenya.

V. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The research objective aimed to evaluate the effect of lean manufacturing practices on operational performance of Sugar Firms in Kenya. This analysis utilized a simple linear regression model to examine the relationship between lean manufacturing and operational performance. The results demonstrated a significant and positive effect of lean manufacturing on operational performance. Specifically, the outcomes indicated that lean manufacturing practices accounted for a considerable extent of the variability in operational performance. Moreover, the regression model revealed that a decrease in the adoption of lean manufacturing practices would result in a corresponding decrease in operational performance. These outcomes highlight the significant impact of lean manufacturing practices in augmenting operational performance for Sugar Firms in Kenya. The findings emphasize the importance of continuous execution and implementation of lean manufacturing initiatives to achieve enhanced operational performance.

5.1 Conclusions

Based on the study's objective, ''to evaluate the effect of lean manufacturing practices on operational performance of Sugar Firms in Kenya'', the study established that lean manufacturing practices had a noteworthy positive and statistically significant influences operational performance. Consequently, it can be concluded that lean manufacturing is a crucial and influential factor in shaping the operational performance of Sugar Firms in Kenya.

5.2 Recommendations of the Study

The research's objective focused on evaluating the effect of lean manufacturing practices on operational performance of Sugar Firms in Kenya. In reference the research outcomes, it is highly recommended that Sugar Firms prioritize and emphasize the utilization of lean manufacturing practices considering its strong positive interplay with operational performance. To achieve and sustain a high level of operational performance, the management of Sugar Firms should invest more resources and effort into adopting and continuously executing lean manufacturing practices. By doing so, Sugar Firms can effectively enhance their operational performance and achieve improved outcomes in their manufacturing processes.

5.3 Suggestions for Further Studies

Future investigators may try to explore the effect of some specific LM tools like single-minute exchange of die, production smoothing, or andon to constitute a metric to measure LM.

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