LEAN MANAGEMENT MODELS APPLICATION AND SAFETY MANAGEMENT OF LOGISTICS FIRM IN NIGERIA

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Abstract: *Research Background: The need for lean concepts application in the safety management of logistics processes cannot be emphasized as it can help in enhancing the flow of information and expediting processes within the supply network for improved organizational outcomes.*
Purpose: The study investigated the application of lean management models to the safety management of logistics firms in Nigeria.
Methodology: The study population includes 215 employees of Manal Plant hire Ltd Nigeria. 138 employees were chosen using a purposive sampling method. A self-administered questionnaire was designed to collect the primary data from the respondents. The data collected were analyzed using the structural equation modeling (SEM) technique to test the hypotheses developed in the study.
Results: The study's findings suggest that Process and Equipment Management has a positive and significant effect on the operational efficiency and workplace safety of the studied firms; employee empowerment has a positive and significant effect on the operational efficiency; technological innovation has a positive and significant effect on the operational efficiency, and that continuous improvement has a positive and significant effect on the operational efficiency and workplace safety.
Novelty: It is, therefore, concluded that the adoption of Lean Management has a positive and significant effect on the safety management of logistics firms. The study recommends that manufacturing, logistics, and service industries should be committed to carrying out process mapping to eliminate non-value adding operations in production as well as logistics and ensure the effective and continuous flow of logistics operations.

Keywords: *Lean Management, Logistics Firm, Management, Operational Efficiency, Workplace Safety.*
(JEL Classification: M11, C38)

INTRODUCTION

Competitive advantage is critical to businesses in today's complex business environment, and there is a growing need for optimal solutions that help businesses establish a competitive edge. Lean Thinking is one of such optimal solutions. Because of the rising dynamism of both internal and external changes in the environment, businesses must continue to enhance their operations processes regularly. The multifaceted notion of lean management, which is rapidly being applied in domestic and international economic practices, requires consideration while looking for ways and strategies to optimize performance (Anna, 2017). Lean Management is often associated with the reduction of waste by "learning" the organisation of any needless tasks. The lean strategy has been applied all across the world, and it has completely altered the service and manufacturing industries. Lean management can help logistics companies improve their performance and outcomes while also lowering costs and increasing employee and customer satisfaction. Effective top-down communication is required to equip employees with clear objectives and consistent mission statements while implementing lean (Cuatrecasas, 2002). Instead of working alone, successful lean implementation necessitated cross-functional collaboration among all employees.

The application of Lean management concepts necessitates the consolidation as well as comprehensive management of components that are more beneficial to the company, such as generally recognized organizational assets – risk, as well as human capital (Charron, Harrington, Voehl & Wiggin, 2014). Internal and external logistic procedures are meant to preserve the right time, location, quality, and cost while supporting the constant flow of manufacturing materials and finishing the delivery to end consumers. Furthermore, all logistic operations in the business must be consistently enhanced, particularly in terms of eliminating excessive waste and operations that do not bring value. Nine logistic areas have been identified where typical Lean losses might arise. These include procurement/purchasing, logistics service and customer support, stock management, delivery and communication, demand forecasting and planning, transportation, material packing, reverse logistics, and, storage among others (Sopadang, Wichaisri & Sekhari, 2014).

The application of Lean concepts in logistics processes management will help to enhance the flow of information that passes through them. In the field of logistics, applying Lean entails several actions to enhance and expedite processes within the supply network, as well as the capacity to function in a variety of, typically insecure, situations for managing the company (Anna, 2017). Maintaining a balance between the customer's needs and the firm's functionality, on the other hand, necessitates proper capacity planning on both operational and strategic levels, standardization of operations and the time required to implement them, and highly qualified, multi-tasking personnel who really can easily accommodate a variety of processes. The majority of the causes of issues in manufacturing processes are linked to the nature of the processes, working conditions, and organization, as well as health and safety. Employees get dissatisfied as a result of the lack of action done to address these issues, which causes them to become less engaged at work. On the other hand, it has an impact on product quality, overall productivity, and competitive position at the corporate level (Furman, 2019).

A well-designed workplace promotes a safer, more efficient, and more productive workplace. It improves employee morale by instilling pride in their job and ownership of their obligations, as well as increasing a firm's competitiveness and profitability in the industry. The creation of educated, empowered, and engaged employees with the information, skills, and opportunity to operate in the workplace 5S (Sort, Set in order, Sweep, Standardize, Sustain) to remove or minimize risks is a cornerstone to worker safety in LM operations (Brown & O'Rourke, 2007). Furthermore, such safety policies are essential for world-class competitiveness; businesses that do not take a strategic approach to corporate safety will be less successful in the future. The addition of "safety" to 5S recently elevated it to 6S.

Lean management, along with its principles, has been touted as a significant tool for improving company performance. It is now widely used in a wide range of nations and sectors (Bhamu & Sangwan, 2014). However, its effectiveness is undeniable, lean management was not without flaws, and its impacts on performance are still hotly debated. Work processes provide varying levels of risk based on the safety dangers inherent in each step necessary to complete the process. Work may be made safer by carefully developing processes to reduce hazards. Lean approaches, which aim to reduce waste and improve efficiency, frequently result in fewer process stages, materials utilisation, and motions required. As a result of these reductions, the safety risks connected with those extra stages or materials may be eliminated or reduced. Reduced work-related accidents and illnesses mean lower expenses for workers' compensation insurance, retraining, and employee turnover (Laura, Isabelina & Joel, 2011).

Studies on how the lean method impacts the operational efficiency of organizations that adopt it have proven equivocal. Several studies have looked into the relationship between LMS and efficiency, particularly in industrial enterprises. Extant surveys of the literature revealed unanimity in favour of the premise that lean manufacturing promotes manufacturing efficiency (Okpala, 2013). Wamalwa, Onkware, and Musiega (2014), on the other hand, discovered that the implementation of the lean culture did not affect manufacturing efficiency. Furthermore, studies have looked at the relationship between safety and lean management, and have discovered a correlation between lean management adoption and increased safety. According to Nahmens and Ikuma (2009), lean is not only a useful tool for improving processes and reducing waste but it is also linked to increased safety in the construction sector. The level of effectiveness in the lean program, according to Wong, Wong, and Ali (2009), was substantially connected with the usage of lean practices in ergonomics and safety. These findings suggest that lean initiatives may have a favorable impact on ergonomics and safety. However, according to Womack, Armstrong, and Liker (2009), lean adoption does not necessarily result in improved ergonomics and safety.

The study on Lean management and safety management has not been given adequate attention in Nigeria. Just a few studies have been conducted thus far e.g Amos, Adebola, Asikhia, and Abiodun (2018); Odeyinka, Oluwaseyi, and Akinyele (2018) and are basically carried out in manufacturing firms with no consideration for logistics firms. Additionally, the use of structural equation modeling for data analysis has not been adequately adopted. The study, therefore, arises from the need to study the application of lean management models to the safety management of the logistics sector in Nigeria adopting structural equation modeling (SEM) for data analysis, a study by Manal Plant Hire Ltd, Nigeria.

LITERATURE REVIEW

In the course of investigating the concept of lean management and its effect on safety management in a logistics firm, the study adopted the Resource-Based View (RBV) theory as the basic foundation for the study. Also, empirical studies in relation to the study were reviewed.

Resource-Based View Theory

The resource-based view (RBV) stresses a company's hard-to-copy features as sources of exceptional performance and growth (Barney, 1986; Hamel & Prahalad, 1996). Resources that are difficult to transfer or acquire, such as those that require a steep learning curve or a major transformation in the organization's environment and culture, are more likely to be unique to the firm and thus harder to imitate. The RBV has shown to be useful in defining the basis on which a company's resources and capabilities function as long-term competitive advantages. As a result, every type of competitive edge is founded on the basis of resources and skills. According to the RBV, the ownership and management of strategic assets determine whether or not a company will make more money and gain a competitive advantage over its competitors.

The RBV looks at the competitive environment in which enterprises operate, but it does so from the inside out, starting with the firm's internal environment. RBV is widely used as a replacement for Porter's five-force model as a result of this. The RBV emphasizes the firm's internal resources and capabilities while developing a plan to achieve a long-term competitive edge in the market. Internal resources and capabilities impact firms' strategic decisions in the external business environment. Some firms' skills also allow them to bring significance to the consumer value chain, launch new products, and expand into new markets. When a firm prioritizes its capabilities in order to get a competitive edge, it will focus on value chain rearrangement. The RBV leverages the resources and capabilities that exist inside the firms to create a long-term comparative advantage (Madhani, 2010).

Umair, Sajjad, Abdul, Hakeem, and Muhammad (2021) assessed the effect of lean and supply chain management practices on business performance. The role of competitive advantage as a mediating factor in the LP, SCMP, and firm performance relationships was also investigated. Data were collected using a simple random sampling approach. The data were analyzed through structural equation modeling techniques. The findings of this research demonstrate that LP, SCMP, and company performance have a substantial positive connection. The research also found that when companies employ the SCMP and LP, they may improve their financial performance.

Lokpriya and Vivek (2020) assessed how Lean and Green techniques and tools are being applied to enhance economic, social, and environmental performance, all of which have a direct impact on the overall performance of a business. The findings suggest that there is a significant connection between Lean and Green and that many Lean methods and technologies may help to enhance environmental sustainability, enabling academics and practitioners to benefit from their synergistic impacts in the manufacturing business.

The goal of Thunyachai, Lonkaniand, and Theeranuphattana (2020) are to learn more about the causal link between lean practices and business performance, with a competitive advantage as a moderating factor. A survey was conducted to determine the influence of six lean techniques, namely manufacturing planning and control, process and equipment, product design, human resource practices, customer relationship, and supplier relations on a company's performance, which includes financial and non-financial indices. The report includes 238 observations from Thai businesses. Ordinary least squares are used to estimate the parameters (OLS). The findings of this study show that lean techniques and non-financial performance have a negative connection. Despite this, there seems to be a strong link between competitive edge and the adoption of lean methods in businesses.

Sven-Vegard, Marco, Jan, and Fabio (2020) based their findings on a cross-sectional study of manufacturing businesses. The study deployed hierarchical multiple regression analysis to examine the connections between the adoption of lean production, factory digitalization, and operational performance. The findings demonstrate that both lean production and factory digitization independently contribute to better operational efficiency while concurrently controlling for the impacts of production repetitiveness, business size, and length of lean manufacturing deployment. Furthermore, they have a complementary (or synergistic) impact when used together that is higher than the sum of their separate benefits. These findings demonstrate that lean production is not outdated, but rather more necessary than ever in capturing the advantages of innovative technologies and transforming them into improved operational performance, particularly in light of the fourth industrial revolution on the horizon.

Prasanta, Chrisovalantis, Debashree, Soumyadeb, and Fouad (2020) examined the influence of LMP, SOI, and CSR (environmental and social) activities on sustainability and economic performance using hypothesis testing and structural equation modeling. The research is based on data from 119 SMEs in the manufacturing industry in the Midlands of the United Kingdom. The findings show that LMP and SOI make it easier to achieve both sustainability and economic performance and that SOI helps LMP achieve sustainability. Furthermore, whereas CSR activities moderate LMP to attain sustainable performance, they only marginally mediate SOI.

Tarurhor and Emudainohwo (2020) investigated the impact of lean manufacturing methods on a firm's performance, including lean culture as a moderating variable in the palm oil industries of Delta state. Palm oil industries, which have been in operation for over 10 years in Delta state, were used as the study's sample. The hypothesis was tested using data from a survey of 433 people. The quantitative data obtained with the aid of a questionnaire were analyzed using the structural equation model in the study. The study discovered that lean manufacturing, as measured by empowerment, training, and development has a favorable and significant impact on a company's product quality performance. The findings revealed that lean culture has a detrimental influence on a company's success. To avoid detrimental effects on the firm's performance, managers should consider the employees' cultural backgrounds as well as the location of the company.

Rodrigues, Alves, and Silva (2020) examined the extent of adopting lean and green practices in a group of firms, as well as the link between lean and green efforts in an industrial setting. The proposed model for the study contributes to the fields of logistics, sustainability, lean, and green in a conceptual way. A statistical method was utilized to build a Structural Equation Modelling (SEM) for lean and green practices to examine the potential of combining lean and green efforts. The findings revealed that the degree of lean and green practice adoption in Portuguese businesses is not effectively addressed or institutionalized. The statistical study also revealed a link between lean environmental practices and green activities. According to the findings, lean and green have a favorable influence on business logistics procedures.

Mohamad (2020) assessed the influence of factors such as lean manufacturing, supply chain relationship, and supplier performance on supply chain performance in Jordanian supply chain businesses. A nonprobability purposive sampling approach was used to obtain 293 answers from Jordanian supply chain experts. In this study, the PLS-SEM was employed. Version 3.2.8 of the SmartPLS software was utilized. Findings reveal that lean manufacturing has a substantial impact on supply chain relationships and supplier performance; however, while SC relationship has a significant impact on supplier performance, it has an insignificant impact on SC performance. Finally, SC performance is influenced by supplier performance.

Iranmanesh, Zailani, Hyun, Ali, and Kim (2019) considered lean culture as a moderator when examining the influence of lean manufacturing methods on a company's environmental performance. The data was collected via a survey of 187 Malaysian manufacturing companies, analysed using the partial least squares method. Process and equipment, customer interactions, supplier connections, and product design all seem to have a positive and substantial influence on long-term performance, according to the findings. It's also worth noting that the impact of process and equipment, as well as supplier relationships on long-term performance, were positively moderated by lean culture. These findings have significant implications for improving manufacturing businesses' long-term performance using lean manufacturing techniques.

Kevin, Imam, and Basuki (2019) investigated the function of management control systems (MCS) in assisting the adoption of lean management strategies to gain a competitive edge and enhance business performance. A questionnaire survey was used to obtain the data. This research included a total of 123 manufacturing executives. Structural equation models were used to go through the data. The findings demonstrate that a lean management approach is connected to MCS and competitive advantage positively and substantially; MCS has a favourable and substantial influence on the competitive edge and firm performance. These findings also suggest that MCS is a mediating variable in the interaction between lean management, competitive edge, and firm performance. The study's findings demonstrate the importance of lean MCS as a component of lean management in achieving a competitive edge and improving firm performance. This is the first proof that MCS mediates the link between the lean management approach, competitive edge, and firm performance.

Ofori-Nyarko, Boison, Asiedu, Agyapong, and Anamoo (2019) appraised the impact of lean operations on company performance while controlling for various business factors. A correlational approach was used, and 162 respondents were chosen from a selected study population of Accra-based beverage manufacturing companies. Hypotheses were tested using correlation tests and structural equation modeling. It was revealed that lean operations improved operational and financial success, but not marketing performance. Firm performance was not affected by any of the controlled variables or firm characteristics (company size, operational capital, firm age, total, and asset). According to the findings, as lean management becomes the more prevalent, the financial and operational performance of firms increases.

Research hypotheses and conceptual model

From the empirical review, the study developed and tested the following hypotheses:

H1 Process and equipment management has a significant effect on operational efficiency and workplace safety in Manal Plant hire Ltd Nigeria

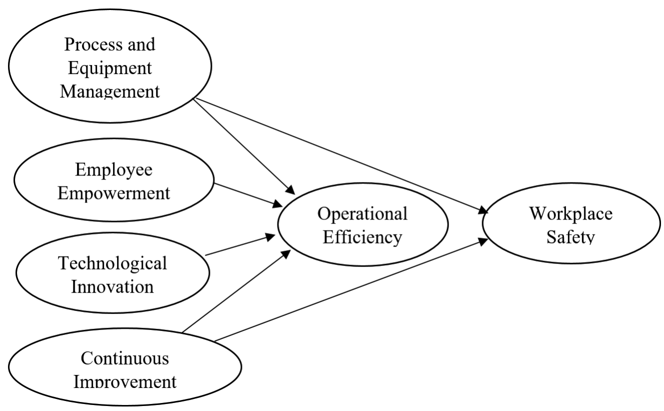
H2 Employee empowerment has a significant effect on operational efficiency in Manal Plant hire Ltd Nigeria.

H3 Technological innovation has a significant effect on operational efficiency in Manal Plant hire Ltd Nigeria.

H4 Continuous improvement has a significant effect on operational efficiency and work place safety in Manal Plant hire Ltd Nigeria.

Based on the hypotheses formulated, and the method of data analysis deployed (structural equation modeling) a research conceptual framework is developed:

Figure 1: A conceptual model of the application of the lean management model on safety management in a logistics firm



METHODOLOGY

The study used a descriptive survey research design to investigate the application of lean management models to the safety management of a logistics firm in Nigeria. The study purposively selected Manal Plant hire Ltd among other logistics firms Ogun State as the study firm, in which its employees make up the target population of the study. The number of employees of the study's firm is two hundred and fifteen (215). The purposive sampling technique was adopted to pick the more reliable participants from the target population. The respondents were selected across the various department of the study firm, which includes: Logistics, Heavy lift, Administrative, and Safety departments. Considering the level of precision, level of confidence, and degree of variability in attributes being measured, the sample size was determined using Krejcie and Morgan's (1970) formula since the population is finite and known. The mathematical calculation is given below:

$$S = x2\ NP(1-P)/(d2(N-1) + X2\ P(1-P)) \text{ ---------- (1)}$$

S = required sample size

X^2 = table value for chi-square for 1 degree of freedom at the desired confidence level of 95% (3.841)

N = the population size

P = estimate proportion of attributes in the population (assumed to be 50% i.e. 0.50 to provide the maximum number of sample size)

d = degree of accuracy or error margin expressed as a proportion +/- 5% (0.05)

Mathematically,

$$S = ((3.841)\ (215)\ (0.5)\ (1 - 0.5))\ /((0.05)2\ (215 - 1) + (3.841)(0.5)(1 - 0.5))$$
$$S = 206.4/\ (0.535 + 0.96025) = 206.45/1.49525 = 138.037$$

S = 138 respondents (approx.)

The study utilized primary data, generated with the aid of primary tool (questionnaire) with closed-ended questions, structured based on the research objectives. The questionnaire was chosen to allow for the systematic gathering of data and facilitates data analysis for business decision. The questionnaire was segmented into sections, such as section A, B, C, D, E, and F. Section A captures the respondents' profiles, section B covers statements related to process and equipment management, adapted from the study of Mohammad et al. (2019); section C presents the statements on employee empowerment in line with Lida, Iravan, Kamran, and Pouran (2019).; section D presents the statements on technological innovation, adapted from the study of Alfred, Reuben, and James (2018); section E covers the statements on continuous improvement; section F presents statements on safety measures, coined by the researcher. The items in section B to G were structured based on a five-point Likert scale: Strongly Disagree (SD), Disagree (D), Undecided (U), Agree (A), and Strongly Agree (SA).

Descriptive statistical analysis was used to achieve the frequency distribution, and percentage, of respondents'' profiles with the aid of a statistical package for social sciences, (SPSS) version 26. Covariance-Based Structural Equation Modelling was deployed with the aid of AMOS Graphics for modeling and analyzing the effect of latent exogenous constructs (human resource planning, information technology, and quality planning) on latent endogenous constructs (productivity and financial performance) As such, the hypotheses developed were tested using the Covariance-based Structural Equation Modelling method and thus, achieve the objectives of the study. CB-SEM method estimates interrelated dependence in a single analysis and produces data in a visual display that is easy to interpret. It also can combine both measurement models and structural models and it is more reliable when assessing the strength of the relationship between two or more latent constructs.

The reliability and validity of the measuring items were assessed using confirmatory factor analysis. The internal correctness and consistency of the research instrument were assessed using composite reliability and Cronbach's Alpha test. The construct validity of the measurement items was investigated, as well as the convergent and discriminant validity of the measurement model.

ANALYSIS

This section discusses the study of respondents' profiles, confirmatory factor analysis for assessing reliability and validity, and structural equation modeling for testing hypotheses.

Table 1: Respondents' Profiles

Responses	Frequency	Percent (%)
Gender		
Male	96	72.7
Female	36	27.3
Total	**132**	**100.0**
Age		
22-31years	43	32.6
32-41 years	47	35.6
42-51years	26	19.7
52years and above	16	12.1
Total	**132**	**100.0**
Qualification		
ND/Equivalent	28	21.2
HND/B.Sc	80	60.6
MBA/M.Sc	24	18.2
Total	**132**	**100.0**
Length of Service		
0-5yrs	45	34.1
6-10yrs	64	48.5
11yrs and above	23	17.4
Total	**132**	**100.0**
Position		
Executive Management	8	6.1
Senior Staff	75	56.8
Junior Staff	49	37.1
Total	**132**	**100.0**
Department		
Logistics	35	26.5
Heavy lift	50	37.9
Administrative/ Safety	47	35.6
Total	**132**	**100.0**

Source: Field Survey, 2021

Confirmatory Factor Analysis

The study employed a pooled Confirmatory Factor Analysis (CFA) to analyse the validity and reliability of the measurement items so as to determine the appropriateness of the measurement model. Below are the factor loadings of the items extracted from the first-order confirmatory factor analysis (CFA).

Table 2: Measurement model evaluation

Constructs	Items	Factor Loadings	Significance
Process and Equipment Management	There is an effective and continuous flow of operations in my firm	0.814	0.000
	Operating machines are readily available and maintain to mitigate risk associated with operations.	0.926	0.000
	The operation process is effectively managed for workplace safety.	0.926	0.000
	Process mapping is carried out in my firm to eliminate non-value adding operations.	0.804	0.000
	Order and cleanliness in operations are implemented in my firm	0.730	0.000
Employee Empowerment	My firm engages in human capital development and creates a safe workplace environment.	0.914	0.000
	My firm engages its employees in continuous improvement efforts in logistics service to minimize the risk associated with logistics.	0.872	0.000
	There are multifunctional (multi-skill) employees in my firm.	0.820	0.000
Technological Innovation	My firm adopts system automation in logistics operations to guarantee workplace safety.	0.954	0.000
	My firm easily adapt to new technology	0.902	0.000
	My firm is highly innovative in managing risk associated with logistics and ensuring workplace safety	0.732	0.000
	My firm continuously improves its production/operation process for effective performance	0.835	0.000
Continuous Improvement	We constantly improve our mode of operation to guarantee workplace safety.	0.869	0.000
	The logistics operations are effectively managed in my firm.	0.751	0.000
	Safety performance evaluation and measurement are effective done in my firm	0.914	0.000
	My firm focused on system improvement to identify core problems and constraints in logistics operations.	0.687	0.000
	Lean practices adopted have improved the work safety in my firm	0.771	0.000
Workplace Safety	The rate of job satisfaction is high in my firm	0.813	0.000
	Our logistics operations have greatly improved.	0.806	0.000
Operational Efficiency	My firm's productivity rate has improved through lean management.	0.981	0.000
	The cost of operation is minimized through the application of lean management.	0.848	0.000

Table 2 shows that the factor loading of each item is > 0.50 and significant, which implies that the factor loadings can be used to assess the reliability and validity of the research instrument.

Table 3: The fitness of the CFA Model

Goodness of fit Statistic	**Model Values**	**Satisfactory values Model fitness**
$\chi 2$ /df	2.454	< 3.00
P-value	0.000	< 0.05
IFI	0.931	> 0.9
TLI	0.908	> 0.9
CFI	0.948	> 0.90
RMSEA	0.066	< 0.08

The CFA model shows a good fit as the revealed that the structural indices such as Incremental Fit Index (IFI), Comparative Fit Index (CFI), Tucker-Lewis coefficient (TLI), and Root Mean Square Error of Approximation (RMSEA) show that the CFA model for the latent constructs satisfies the required level of model fit. Since the indices for attaining the fitness of the CFA model have corresponding values that are larger than the suggested values, they are a perfect fit. The CFA model is seen to be a good fit.

Table 4: Reliability and Validity of the Constructs

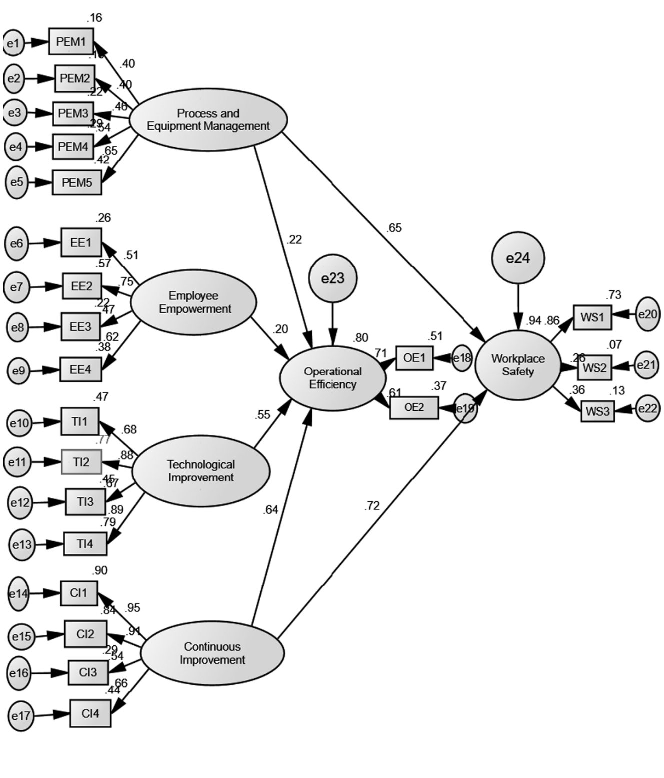
Constructs	CR	Cronbach's Alpha	AVE	PEM	EE	TI	CI	WS	OE
Process and Equipment Management	0.974	0.925	0.711	**0.843**					
Employee Empowerment	0.903	0.944	0.786	0.239	**0.886**				
Technological Innovation	0.901	0.922	0.739	0.275	0.420	**0.860**			
Continuous Improvement	0.890	0.883	0.657	0.661	0.076	0.077	**0.810**		
Workplace Safety	0.839	0.838	0.635	0.576	0.160	0.142	0.611	**0.797**	
Operational Efficiency	0.913	0.944	0.841	0.511	0.239	0.230	0.808	0.743	**0.917**

Note: The Off-diagonal values are correlations between constructs, while the diagonal values (in bold) are the square root of AVE between the latent constructs.

The average variance extracted (AVE), Cronbach's alpha and composite reliability (CR) were computed to assess the convergent validity and reliability of the research instrument. The convergent validity was substantiated by computing the AVE for each of the latent constructs and the threshold for convergent validity is that the value of the AVE of the latent constructs should be ≥ 0.5 (Sobh, 2010). Furthermore, the reliability of the research instrument was tested to assess its internal accuracy and consistency by adopting composite reliability and Cronbach's alpha test. The reliability test was also done to assess the shared variance among the latent constructs. According to Hair, Hult, Ringle, and Sarstedt (2016) the benchmark for Cronbach's alpha and CR is that the value of Cronbach's alpha and composite reliability of a latent construct should be ≥ 0.7 for the study. As shown in Table 4, Cronbach's alpha and composite reliability of the constructs is > 0.7; the average variance extracted (AVE) of the constructs is > 0.5, thereby confirming the internal accuracy and convergent validity of the constructs.

The discriminant validity of the constructs was assessed based on the hypotheses developed in the study. When operationalized, discriminant validity explains the level of relationship or divergence between two variables that should not be theoretically comparable, i.e. the amount to which a construct is separate from others and does not measure the same thing. It is a must to recognize and comprehend the significance of a variable. Table 4 shows the relationship among the constructs with the square root of the AVE on the diagonal. The values of the square root of AVE, i.e., the diagonal values (in bold) for each of the constructs, are more than the inter-correlation values of the constructs, indicating that the constructs met the benchmark of discriminant validity (Lin & Chen, 2008). Furthermore, the results show that there is a weak to moderate positive relationship within the constructs. The correlation coefficient within the variables is between r = 0.011 and 0.787, all were below 90%, validating the nonexistence of any common method bias. Since the results of the correlation test are less than the threshold of r < 0.9 according to Pallant (2010) it implies that there were no multi-collinearity problems among the variables.

Figure 2: Structural Model for the Application of Lean Management Models to Safety Management



Test of Hypotheses

The study adopted CB-SEM for test of hypotheses, which is a path analytical model to ascertain the causal effect of the latent exogenous variables on the latent endogenous variables in the study.

Figure 2 displays the path diagram resulting from the structural modeling analysis. The path analysis assessed the degree of the association between the exogenous variables and the endogenous variables in the model. The arrows between the constructs in the path analysis depict the alternate hypothesis, it implies that the independent constructs (process and equipment management, employee empowerment, technological innovation, and continuous improvement) are expressed in alternate hypotheses to have a significant effect on the dependent constructs (operational efficiency and workplace safety). The model's explanatory power is assessed by two values: R^2 (squared multiple correlations or regression) and path coefficient. The path coefficients demonstrate the effect of the independent construct on the dependent construct. The R^2 shows the proportion of variance a dependent construct represents in the model. As shown in the path analysis, the R^2 value for operational efficiency is 0.80. This implies that the predictors (process and equipment management, employee empowerment, technological innovation, and continuous improvement) of Lean Management, taken as a set explained 80.0% variation in operational efficiency. The R^2 value for workplace safety is 0.94. This implies that the predictors (process and equipment management, and continuous improvement) explained a 94.0% variation in workplace safety.

Table 5: The fitness of the Structural Model

Goodness of fit Statistic	**Structural Model Values**	**Recommended* values for good fit**
$\chi 2$ /df	2.72	< 3.00
P-value	0.000	< 0.05
NFI	0.926	> 0.9
IFI	0.946	> 0.9
CFI	0.935	> 0.90
RMSEA	0.057	< 0.08

From the test result of the SEM model in table 6, it is observed that the structural indices adopted such as Incremental Fit Index (IFI), Normed Fit Index (NFI), Comparative Fit Index (CFI) and Root Mean Square Error of Approximation (RMSEA) show that the SEM model for the constructs satisfies the threshold of model fit. The structural model is judged to have a good fit since the indices for obtaining the goodness of fit of the structural model demonstrate an acceptable fit with their corresponding values larger than the required values.

Table 6: Direct effect of lean management models on safety management

Links in the model	Hypotheses	Path Coefficient	Critical Ratio (CA)	p-value	Result
PEM→OE	H_{1a}	0.22	2.288	0.022	Accepted
PEM→WS	H_{1b}	0.65	5.721	0.000	Accepted
EE→OE	H_2	0.20	2.086	0.037	Accepted
TI→OE	H_3	0.55	6.119	0.000	Accepted
CI→WS	H_{4a}	0.64	5.979	0.000	Accepted
CI→OE	H_{4b}	0.72	7.654	0.000	Accepted

Table 6 shows the direct effect of lean Management models (process and equipment management, employee empowerment, technological innovation, and continuous improvement) on safety management proxied by operational efficiency and workplace safety. Based on the results of the path analysis, the path coefficient of process and equipment management to operational efficiency is 0.22, which implies that a unit increase in process and equipment management explained a 22.0% variation in operational efficiency. The path coefficient of process and equipment management to workplace safety is 0.65, it implies that a unit increase in process and equipment management explained 65.0% variation in workplace safety. The path coefficient of employee empowerment to operational efficiency is 0.20, it implies that a unit increase in employee empowerment explained a 20.0% variation in operational efficiency. The path coefficient of technological innovation to operational efficiency is 0.55, it implies that a unit increase in technological innovation explained a 55.0% variation in operational efficiency. The path coefficient of continuous improvement to operational efficiency is 0.64, it implies that a unit increase in continuous improvement explained 64.0% variation in operational efficiency. The path coefficient of continuous improvement to workplace safety is 0.72, it implies that a unit increase in continuous improvement explained a 72.0% variation in workplace safety.

Furthermore, the critical ratio (CR) for all hypotheses is greater than 1.96. p-vale < 0.05, which implies that the direct effect of all the latent dependent constructs on the dependent constructs is significant.

In summary, H_{1a} is accepted, thereby, accepting the alternate hypothesis and concluding that process and equipment management has no positive and significant effect on operational efficiency. H_{1b} is accepted, thereby, rejecting the null hypothesis and concluding that process and equipment management has a positive and significant effect on workplace safety. H_2 is accepted, thereby, rejecting the null hypothesis and concluding that employee empowerment has a positive and significant effect on operational efficiency. H_3 is accepted, thereby, rejecting the null hypothesis and concluding that technological innovation has a positive and significant effect on operational efficiency. H_{4a} is accepted, thereby, rejecting the null hypothesis and concluding that continuous improvement has a positive and significant effect on operational efficiency; H_{4b} is accepted, thereby, rejecting the null hypothesis and concluding that continuous improvement has a positive and significant effect on workplace safety.

Table 7: Results Summary

NO	Critical Ratio (CA)	Path Description	Study's findings
H_{1a}	Process and Equipment Management→ Operational Efficiency	FWS→EP	Accepted
H_{1b}	Process and Equipment Management→ Workplace Safety	FWS→OE	Accepted
H_{2a}	Employee Empowerment→ Operational Efficiency	JA→EP	Accepted
H_{2b}	Technological Innovation→ Operational Efficiency	JA→OE	Accepted
H_{3a}	Continuous Improvement→ Operational Efficiency	SS→EP	Accepted
H_{3b}	Continuous Improvement→ Workplace Safety	SS→OE	Accepted

DISCUSSION AND CONCLUSION

The findings reveal that Process and Equipment Management has a positive and significant effect on the operational efficiency and workplace safety of the studied firms. This depicts that the surveyed firm carries out process mapping to eliminate non-value-adding logistics operations and ensures an effective and continuous flow of logistics operations. This enhances the operational efficacy of logistics firms and guarantees the safety of the employees in the process. These findings are consistent with Iranmanesh et al. (2019) revealing that process and equipment, customer interactions, supplier connections, and product design all appear to have a positive and substantial impact on long-term performance, according to the findings. It's also worth noting that the impacts of process and equipment, as well as supplier relationships, on long-term performance were positively moderated by lean culture. In contrast, Thunyachai et al. (2020) in their findings revealed that lean techniques (manufacturing planning/control, product design, process and equipment, human resource practices, customer relationship, and supplier relations) have a negative connection with non-financial performance. However, there seems to be a strong link between competitive advantage and the adoption of lean methods in businesses. According to Bergmiller (2006), over-processing and the resulting machinery use wastes energy and resources while also increasing emissions production. Over-processing results in the production of toxic compounds and pollutants, as well as increased water use and energy waste. The findings show that employee empowerment has a positive effect on the operational efficiency of the studied firm. The result reflects that the employees are productively engaged in continuous improvement efforts in logistics service to improve logistics performance and minimize the risk associated with logistics. This result is consistent with those of Bhasin (2012); Fullerton Kennedy, and Widener (2013). Employee empowerment, according to Maskell, Kariuku, and Kiambati (2012), helps the application of lean management practices as a social control mechanism. It was also discovered that successful empowerment equips workers with the information and competence they need to make sound decisions and take action to accomplish the key success characteristics of lean management. Keitany and Riwo-Abudho (2014) revealed that changing management style and incorporating all employees at all levels, as well as improved inventory management, results in a more effective lean manufacturing process. Human resources practices, according to Iranmanesh et al. (2019), played a critical part in lean manufacturing by fostering a positive working environment and fostering human capital development. It will be difficult to find a company that can fulfill its objectives without human resources. Human resources have a major role in a firm's ability to execute lean manufacturing, produce high-quality goods, and gain a competitive edge over competitors.

Furthermore, the findings reveal that technological innovation has a positive effect on the operational efficiency of the firms understudied. The study shows that system automation adopted in logistics operations guarantees workplace safety. It is also indicated that the surveyed firm is highly innovative in managing risk associated with logistics to facilitate efficient operation in logistics. This result supports the findings of Lida, Iravan, Kamran, and Pouran (2019), who found that technology has the biggest influence on the pattern of lean management in public hospitals to enhance service quality. Ker, Wang, Hajli, Song, and Ker (2014) examined the role of lean technology in improving hospital service quality and reducing waste and found that using digital scanning technology reduced time procedures significantly. Sven-Vegard et al. (2020) show that lean production is not outdated, but rather more important than ever in capturing the advantages of new technologies and converting them into enhanced operational performance, particularly in light of the fourth industrial revolution on the horizon.

Finally, the findings reveal that continuous improvement has a positive and significant effect on operational efficiency and workplace safety in the studied firms. The results show that the firm has focused on system improvement to identify core problems and constraints in logistics operations. Safety performance evaluation and measurement are effectively carried out to constantly improve the mode of operation and guarantee workplace safety. These findings are consistent with previous research. According to Openda (2013), the majority of Kenyan businesses feel that lean manufacturing approaches, such as continuous improvement, promote long-term performance and success. Less process waste, decreased inventory, shorter lead times, lower rework costs, and improved process knowledge was identified as benefits of using lean manufacturing principles in the research. According to Gableta, Cierniak-Emerych, and Dziuba (2016), a firm that decides to use the 6S (sort, set in order, shine, standardize, sustain, and safety) method of lean must adopt a preventative strategy defined by the discovery of all dangers that may in the future become the root cause of an accident, for which improvement activities should be offered in line with the specific phases of 5S. This method will enable the establishment of a secure workplace.

Lean management, along with its principles, has been touted as a significant tool for improving company performance and safety management. It is now widely used in a wide range of sectors. Generally, as the application of Lean Management becomes more prevalent, company performance in terms of operational and financial performance increases. The study draws specific conclusions: The LM practices adopted by Logistics firms have a positive and significant effect on operational efficiency and workplace safety, as they optimize the logistics operations and guarantee the safety of the employees in the process. In view of this, Logistics firms should put in place a focused system improvement to identify the core problem and constraints in logistics operations, and that safety performance evaluation and measurement should be carried out effectively to constantly improve the mode of operation and guarantee workplace safety.

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