The Operational Efficiency of Vehicle Manufacturing in Nigeria: The Lean Tool Option

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Abstract: The demand for customer-focused manufacturing calls for more user-friendly tools to make workflow as smooth as possible. One of the lean tool options integrated into the automobile industry to tackle problems associated with product quality, brand appeal, and waste elimination at every stage of production processes is the Value Stream Mapping (VSM). Though manufacturers adopted several lean tools to minimise cost and reduce waste, this study focused on the roles of Value Stream Mapping (VSM) on the operational efficiency of Innoson Vehicle Manufacturing Company of Nigeria. A descriptive survey design was used to structure and organise this study. The convenience sampling technique was used to select 110 management and supervisory staff from the 1,800 employees of Innoson Vehicle Manufacturing Company of Nigeria. Data gathered were analyzed using the Ordinal Logistic Regression (OLR) model in the Statistical Package for Social Sciences (SPSS) Version 21. The null hypothesis that VSM as a Continuous Improvement (CI) tool does not enhance the firm's Operational Efficiency (OE) was rejected at a LOGCI of 872.31 and p-value of .001. The hypothesis, that waste elimination through VSM does not influence operational efficiency, was also dismissed. The findings revealed that VSM performance is demonstrated when teamwork in an assembling procedure, interacts with the production system and watches how production evolves from a starting point (inputs) to an end item (output). It was concluded that to achieve operational efficiency, businesses must minimise waste of processes, raw materials, time and space. VSM helped the managers to visualise more than just the single-process level, enabling the managers to view job flow across all processes. We recommended VSM to the manufacturing and the service industry for the implementation of plans and actions.

Keywords: Continuous Improvement, Lean, Manufacturing, Operational Efficiency, Value Stream Mapping, Waste Elimination

I. Introduction

Technology is evolving at a rapid pace and this has created many opportunities for creativity and innovation globally. Many industries have been putting more and more effort into creating distinctive and cutting-edge items that combine future elements with contemporary necessities.

Companies, attempting to minimize costs of production and overcome negative economic trends, adopted different strategies, methods, and programs to get things done. Better yet, many manufacturing firms have embraced bigger ideas on how to navigate in times of natural disasters and economic downturns.

With the limitless opportunities in the automotive sector, electrification and connectivity are two significant areas that will eventually propel the automotive sector forward (IEA, 2021). Policy changes are the main forces behind these movements and the Industrial Internet of Things (IIOT) uses interconnected equipment in manufacturing to gather data that can be utilized to improve the manufacturing process. One type of connected IIOT is the sensor. Manufacturing has changed dramatically as a result of automation, which allows businesses to improve accuracy, boost production, and streamline operations. According to Damini (2022), these are achieved in organizations through the amalgamation of robotics, intelligent machines, and sophisticated software applications. For instance, sensor data from manufacturing equipment is used to predict when problems will arise, optimize maintenance procedures, and better understand how well machines are working. Manufacturers benefitted greatly from automation in several ways, including increased accuracy, reduced costs, and increased production. We might even witness an increase of fully automated factories, also referred to as "dark factories", automated locations where manufacturing takes place without the need for direct human involvement on-site. Electric vehicles (EVs) are anticipated to become more reachable and available worldwide. The aforementioned are possible through diagramming and visualizing every aspect of the process. Generally, the popular slogan in the factory “the master of the machine” is a known lean strategy that involves a visual representation of the flow of materials, processes, and other resources throughout the value chain.

Lean methodology was implemented in five steps to achieve the outlined efficiency in the automobile industry, according to Andreadis (2017); to solve manufacturing problems and provide value to customers and stakeholders, the steps were determining the process's worth, determining its value stream, concentrating on its flow, setting up the pull factor, and striving for operational flawlessness. Lean orientation was practised using a variety of tools such as Poka-yoke, Value Stream Mapping (VSM), and Total Productive Maintenance (TPM), among others. (Mishra et al., 2020). All these lean tools play vital roles in enhancing automobile firms’ performance.

The VSM as a lean technique was first developed and implemented by the Toyota Production System in Japan in the 1980s. Toyota Corporation was able to identify and eliminate non-value activities in its production system, leading to improved operational efficiency. Manufacturers benefited from and reduced waste with the use of this VSM**.** This study was conducted to evaluate the roles of value stream mapping as a veritable lean option for operational efficiency in the Innoson Vehicle Manufacturing Company of Nigeria.

Statement of the Problem

For many years, automakers and Original Equipment Manufacturers (OEMs) faced the problem of providing consumers with an extensive selection of vehicles outfitted with cutting-edge technologies. These challenges arose due to ambiguous production steps that resulted in overproduction, high waiting time, extra processes, product defects, and bogus inventory. To achieve that, companies started mapping out workflow, a process that visualizes and analyses processes, identifies inefficiency and eradicates waste of resources. Value stream mapping became a vital lean tool that showed how future tasks would be completed. Value stream mapping encourages the invention of digital sensors and chips that aid in the production of goods and services. The invention of Digital Products (DPs) is a typical innovation developed to solve problems associated with manufacturing.

Objectives of the Study

This study was aimed at evaluating the role of Value Stream Mapping (VSM) on the operational efficiency of Innoson Vehicle Manufacturing Company of Nigeria. Two objectives specifically examined are:

(i). to evaluate the effect of VSM as a continuous improvement tool on operational efficiency of Innoson Vehicle Manufacturing Company of Nigeria.

(ii). to analyse the effect of VSM as a waste eliminator on the operational efficiency of Innoson Vehicle Manufacturing Company of Nigeria.

Hypotheses of the Study

The following null hypotheses were expostulated in the course of this study.

(i). VSM as a Continuous Improvement (CI) tool does not enhance the operational efficiency of Innoson Vehicle Manufacturing Company of Nigeria,

(ii). Waste elimination through VSM does not influence the operational performance of Innoson Vehicle Manufacturing Company of Nigeria.

II. Conceptual Review of Literature

The word "lean" was created by Womack and his colleagues to refer to a system that uses less inputs altogether while giving the customer more options while producing outputs that are on par with those of the traditional mass production system. A collection of methods and instruments known as lean manufacturing are used to continuously reduce waste in the production process, guarantee the creation of high-quality products and the availability of high-quality services, and increase employee productivity (Jones and Womack, 1996; Holweg, 2007). The Key Philosophies behind lean manufacturing are summarized as follows:

(i). Waste recognition: According to Womack and Jones (1996), one of the primary goals of putting a lean approach into practice is to get rid of anything that doesn't improve the product or service. To produce high-quality items and services for the company's clients or consumers, lean manufacturing is used. Customers are worried about paying for the same amount of goods and services that they receive from a business (Tauchi, 1998). Therefore, it's critical to identify and eliminate anything that buyers are unwilling to get.

(ii). Standard procedures: Standard Work, a set of extremely comprehensive production instructions that specify the content, order, timing, and result of every action taken by employees, must be implemented to follow Lean. (iii) Quality at the Source: Lean strives for defects to be eliminated at the source and for workers to perform quality inspection as part of the in-line production process. (iv) Continuous flow: Lean typically aims to implement a continuous production flow free of bottlenecks, interruptions, detours, backflows, or waiting. (v) Perfection: The main goal of applying lean production is to achieve excellence. Producers must cultivate the perspective that every process can be improved and that a process is never perfect (Maware and Adetunji, 2019).

Value Stream Mapping as a Strategic Lean Option

Value Stream Mapping (VSM) is one of the most crucial tools for lean manufacturing. It finds and minimizes erroneous activities, losses, and delay times to boost valuable times, which leads to improved product quality by enabling the production of units in terms of risk mitigation and ongoing expense diminution. A lean management technique called value stream mapping is used to show, evaluate, and enhance the workflow necessary to provide a customer with a good or service. To ascertain cycle times, wait times, and quality/completeness metrics at each stage, the procedure entails identifying every workflow step from start to finish and gathering process data. Applying lean concepts, procedures, and instruments to maximize the flow of value to clients is known as value stream management (Brown, 2024).

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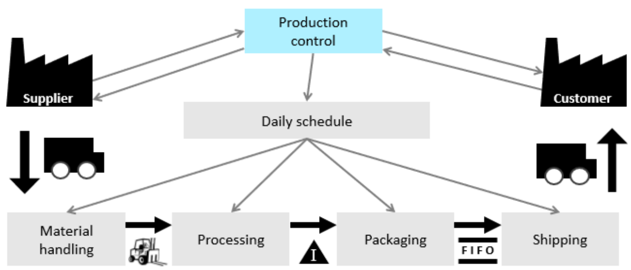
Designed with the Japanese automobile industry in mind, lean management encapsulates the ideas, practices, and guidelines for organizing businesses and their operations in a way that is both productive and efficient. It seeks to reduce waste and maximize value for the client. Wastes are actions and procedures that bind resources without yielding any benefit (Womack and Jones, 2013). A method of thinking known as "lean management" makes it possible to identify value and to divide and arrange time and process steps that provide value and those that don't.

Value Stream Mapping (VSM): VSM is a lean instrument that uses a flow chart to validate every phase in the production process (Brown, 2024). The concept is fundamental for identifying waste, lessening cycle times, and applying continuous improvement. VSM is an important component in lean management and it is an agile procedure that raises customer value by eradicating unused items from individual production phases. Asana (2023) identifies 4 steps in value stream mapping; charting the present process, discovering and eradicating wastes, mapping enhanced future processes, and implementing future procedures.

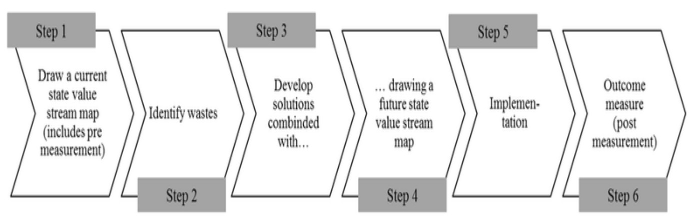
Figure 11: A Simple Value Stream Map of the KYS Manufacturing Firm



Sourc: CI toolkit (2024)

The four steps have been designed to map out all activities (both value and non-value added) in the value stream of the production process, giving firms the chance to analyze the flow of raw material from suppliers to end customers thereby making it useful for decision-making in leveraging competitiveness which is also key to flexibility as measured in with lead time (Modi and Thakkar, 2014). It therefore promotes the usefulness of collaboration in the manufacturing environment, that is, managing quality within the value chain thereby improving food production and service (Ahmed *et al.,* 2015), reducing operational costs, inculcating agility, and meeting the demands of their customers (Shrafat and Ismail, 2018).

The VSM method entails visualizing intricate workflows, estimating all required resources (e.g., personnel, supplies, and time), and reorganizing the workflows into an enhanced form that prioritizes the patient's needs (Jimmerson C., 2010). As a result, VSM seeks to reduce pointless process steps and time. Figure 1 presents steps to visual stream mapping.



Source: Novak et *al., (*2017*)*

The connection between the sums of time devoted to a process and the percentage of time that provides benefit has historically been taken into account in value stream mapping (Vinodh et al., 2013). This would highlight the actions that would be overly time-consuming and provide no value. Although this timeline would provide a comparison between the two visually, it did not account for the resources required or waste generated in the process.

Challenges faced while implementing VSM

The effectiveness of Value Stream Mapping (VSM) in streamlining processes and identifying areas for optimization can be hampered by a number of issues, such as the absence of collaboration across functions, resistance to change, challenging data gathering, identification of non-value-added phases, variations in processes, insufficient backing from management, and issues maintaining modifications after the original visualisation is finished.

For VSM to be implemented successfully, the three sustainable dimensions of economic, environmental, and social must be brought into harmony with digitization. Certain crucial elements of intelligent, sustainable features were mostly disregarded. These are some essential recommendations for the SS-VSM analysis metrics.

(A). Continuous Improvement through Value Stream Mapping

To remain competitive, firms must preserve low switching costs, minimize conversions, lower manufacturing costs, and eliminate waste. The application of continuous improvement, also known as kaizen, is a company-wide approach to determine and maintain progressive improvement (Brown, 2024). Continuous improvement is being created akin to quality management techniques, which aim to improve the firm through continuous rationalization (Bhuiyan and Baghel 2006) by adding value to every productive system (Abasiubong *et al.*, 2023). VSM is a technique that helps analyze the content and knowledge flows that must occur to get a product to the customer. Using this method, anyone can observe the steps and interaction flows within the value stream or process (Nash and Poling, 2008). This technique has become more and more popular in the continuous improvement field because it can quickly gather, analyze, and display data. It is impossible to overstate the contribution that Continuous Improvement (CI) makes to improve the calibre of processes and products. An organisation can gain from continuous improvement in some ways, such as less waste, improved quality, and system performance (Bugvi, *et al.*, 2021), improved quality and efficiency (Goh, 2000), higher customer satisfaction (Taylor & Hirst, 2001), and more staff commitment.

(B). Waste elimination through Visual Stream Mapping

Any material or feature not essential for generating value from the customer's perception is waste and should be eliminated. One of the main aims of implementing a lean strategy is the elimination of everything that does not add value to the product or service (Womack *et al.*, 2013). Waste from overproduction, carriage waste, processing excess, catalogue waste, waste of waiting time, waste of motion, and waste from creation blemishes. Lean manufacturing generates quality goods and services for the company's clients or customers. Buyers of goods and services are concerned with paying for the equivalent worth of goods and services that they get from a company (Tauchi, 1998). Hence, it is essential to recognize and remove every waste that the purchasers are not keen to pay for. The value stream mapping concept is a fundamental tool for identifying waste, lessening cycle times, and applying continuous improvement. VSM is an important component in lean management and it is an agile procedure that raises customer value by eradicating unused items from individual production phases.

(C). Operational Efficiency

Efficiency, according to Mankins (2017) is the ability to provide the same result with fewer inputs. Managers must decide which input and output variables are most appropriate for their organisation to calculate efficiency. Operational efficiency is, therefore, referred to as the practice of optimizing materials and corporate operations to save operating expenses and boost or preserve productivity (Gomstyn and Jonke, 2024). The formula for calculating operational efficiency is to divide the input (resources, man-hours, licenses, methods) by the output (sales, revenue, cold calls, incoming leads, and product). Key performance indicators (KPIs) are measurable measurements that indicate the health of a business and are used to determine these variables (definition). These indicators offer objective performance information, which can throw light on the general path of a company.

To enhance an organization's efficiency at work, waste must be identified and improvements must be made to boost productivity. Businesses in the modern world's economy, from manufacturers to providers of energy are under growing demand from investors to increase operational efficiency. Attaining operational efficiency can be crucial in highly competitive markets because it enables businesses to offer premium goods and services at competitive rates while preserving or growing their profits. According to PWC (2019), 77% of chief executive officers worldwide surveyed stated they will look for operational efficiencies to boost overall profit growth. Operational efficiency is all about oiling, lubricating, energizing, and digitalizing productive systems to perform accurately with less effort/resources. It is also related to the lean philosophy of using less to achieve more.

Empirical Review of Related Studies

Batwara *et al.*, (2024) examined the Smart sustainable value stream in an organization using a framework that combines smart, sustainable, and lean methods. The best SS-VSM approach is chosen using a fuzzy-based Preference Selection Index (FPSI) method that takes environmental, social, and economic factors into account. Sensitivity analysis evaluates the method's resilience. The findings help SMEs improve performance through SS-VSM practices by providing a theoretical structure for organizing and carrying out VSM.

Ajayi and Laseinde (2023) use value stream mapping to examine the demands of the fourth industrial revolution and the possibilities of business process management among agro-allied enterprises. According to the research's conclusions, the agro-allied sector is still not reaching its full potential. Investors are incredibly unaware of how to utilize VSM to guarantee an effective process of production. The analysis suggests more research on the significance of VSM to guarantee that agro-allied waste is greatly reduced.

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. PPMC in the Statistical Package for Social Sciences (SPSS) was used for data analysis. A positive association was established by the research between Lean manufacturing and operational performance. However, the study adopted a survey method that does not encourage respondents to provide accurate and honest judgment.

Bugvi, *et al.*, (2021) in their study on performance improvement through value stream mapping use quantitative and survey designs to gather data from small and medium-scale enterprises in Pakistan. The analyses indicated a reduction of around 21% in the production lead time for 100 units and about 19% in the processing time for each unit. The study shows performance improvement through the implementation of a pull system, supplier interactions, layout and manufacturing process modifications,

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Just in Time (JIT) delivery of parts and materials, effective scheduling of transportation resources, and the reduction of stock buffers.

Pokuaa and Nadarajah (2020) carried out a scholarly study on visual stream mapping (VSM) as one of the lean tools for ensuring information flow and removing excess, supported by theories like the relational view and dynamic capabilities. A descriptive research design was used in this study. Data were collected from 74 food processing firms by administering a questionnaire random sampling technique. The researcher analysed the data using least square-structured (PLS) equation modelling. The proposed model established the direct and indirect effects of VSM on operational performance through the influence of supply chain collaboration (SCC) in the food processing industry context, including multiplicative stages, product family identification, and performance comparison.

Vasconcelos, F. L. et al. (2020) evaluated the applicability of VSM to the oil and gas chain processes in selected oil firms in Brazil. The study identified the framework companies used to map their processes, identify wastes, and create future state maps with improved information and material flows. The study showed future VSM implementation prospects, particularly increased productivity and reliability of this lean tool. This research identified issues with VSM implementation, examined possible reasons, and developed suggestions to make the process less complicated and more likely to succeed.

Singh, B. *et al.*, (2011) carried out a literature review on the implication of value stream mapping in the Indian small manufacturing industry. The study evaluated reductions in lead time, processing time, work-in-process inventory, and staffing requirements. The study revealed the findings of the conducted case study. Work in process inventory was reduced by 80.09%, finished goods inventory was reduced by 50%, product lead time was reduced by 82.12%, station cycle time was reduced by 3.75%, change over time was reduced by 6.75%, and manpower was reduced by 16.7%.

Nowak, *et al.* (2017) examined value stream mapping in enhancing operational performance in healthcare systems. A descriptive design was used in the study. 22 survey samples were obtained from Pubmed, EBSCOhost and Web of Knowledge. For data synthesis, all study data were categorised into Donabedian's model of structure, process, and outcome quality. The findings revealed the significant effect of VSM on the time dimension of process and quality outcomes because of its capacity to reduce non-value-added time. **Pokuaa and Nadarajah (2020) indicated** that VSM ensures waste elimination and structural revision, leading to an efficient manufacturing process, and also enabling the customer to receive orders significantly faster as affirmed by Dadashnejad and Valmohammadi (2018) in production process improvement, in terms of higher customer satisfaction due to cost decreases and quality improvement. The most important problem-finding and solving tools in the Netherlands were the problem identification tools, process mapping tools, display/visualization tools, and seven basic quality tools. Keykavoussi and Ebrahimi (2020) use fewer VSM's important tools such as simulation, Six Sigma, and QFD.

III. Methodology

The major aim of this study was to evaluate the effect of value stream mapping on enhancing the operational efficiency of Innoson Vehicle Manufacturing Company in Nigeria. The descriptive survey design was used to structure, organize and comprehensively present the study. Over one thousand eight hundred (1,800) people work at Innoson Vehicles and they are skilled in design, engineering, manufacturing, quality control, marketing, and other areas of automobile assembling. A sample size of 110 management and supervisory staff of the company was conveniently selected from the 1800 employees of the Innoson Vehicle Manufacturing Company. A well-structured closed-ended questionnaire was administered to the sampled respondents using the 5-Point Likert Scale. Hence, 1 represents Not Effective at All (NE), 2 Somewhat Effective (SE), 3 Neutral (N), 4 Effective (E), and 5 Very Effective (VE).

Table 1: Summary of Questionnaires Administered and Collected

Categories of Workers and Department	**N0. Of Questionnaire**		**Percentage Retrieved (%)**
	Served	Retrieved	
Leadership Team	9	4	44
Manufacturing Unit	50	45	90
Engineering/Automation Unit	20	10	50
Accounting unit	5	5	100
R &D	8	6	75
Design Department	8	6	75
HR	5	4	80
Quality Control	5	3	60
	110	84	76%

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Field survey data (2023)

Table 1 shows the summary of total number of questionnaires administered and collected. The decision to utilise the questionnaire above other forms of scientific enquiries for this study was founded on its economy, standardisation, and convenience (Creswell and Clark, 2011).

Data were analysed using an Ordinal Logistic Regression (OLR) model. The result from the analysis was used to draw an inferential conclusion and make recommendations on how VSM can be utilised to increase the operational efficiency of Innoson Vehicle Manufacturing Company.

Data Presentation

Data collected from the study respondents are summarily presented in Table 2.

Table 2: VSM as a Continuous Improvement (CI) tool for Operational Efficiency (OE)

SN	ITEM	NE	SE	N	E	VE
1	How would you rate the organisation's commitment to CI?	11.20**	33.60**	33.60**	2226.20	55 65.50
2	VSM is an effective tool used to analyze production processes in your department	0	67.10**	67.10**	3036.00**	4250.00**
3	Do CI initiatives lead to significant process improvements?	0	11.20**	33.60**	3339.20	4756.00**
4	CI plans are effectively associated with corporate goals and strategies.	0	22.40**	11.10**	2327.40	5869.05**

Source: Researcher's Computation (2024)

Table 4.2 shows the responses used in assessing how VSM aids continuous improvement in Innoson Vehicle Manufacturing efficiency. When asked how would you rate the organisation's commitment to CI? 65.50**% of the respondents said it is very effective (VE), and 26.20**% says is effective. 3.60**% said Somehow Effective (SE) remained neutral with the assertion Concerning How effective VSM is to analyze and improve processes in your department, 50.00**% of the total respondents agree it is Very Effective (VE) while 30.00**% of the respondents agree that it is Effective (E). 7.10**% were Neutral (N) while 7.10**% opined that VSM was Somehow Effective (SE). 47 respondents, 56.00**% agreed that CI initiatives were Very Effective (VE) and significant for process improvements. 33 respondents 39.20**% said were Effective while 3.60**% and 1.20**% said were Neutral (N) and Somehow Effective (SE) respectively. 69.05**% and 27.40**% said CI plans are Very Effective (VE) and Effectively (E) associated with corporate goals and strategies. 1.10**% and 2.40**% have contrary views. The asterisk shows the infinity of the figures.

Table 3: VSM as a waste elimination tool for Operational Efficiency (OE)

SN	ITEM	NE	SE	N	E	VE
1	How effective is VSM in identifying wastes in our productive system?	22.3**	44.7**	00.00	4047.6**	38 45.2**
2	VSM is an effective tool used to eradicate waste in our production facility.	11.1**	78.3**	44.7**	3238.0**	4047.6**
3	VSM provide a prime, significant change in our production processes.	0	89.5**	55.9**	3136.9**	4250.00**
4	The strategy is effective in reducing waste of raw materials, processes, and space.	22.3**	44.7**	44.7**	1619.0**	5869.0**

Source: Researcher's Computation (2024).

Table 3 explains the respondents' responses about VSM as a waste elimination tool in Innoson Vehicle Manufacturing's Operational Efficiency (OE). The question "How effective is VSM in identifying wastes in our productive system?" 45.2**% of the respondents said it is very effective (VE), and 47.6**% said is Effective (E). 4.7**% said Somehow Effective (SE). Regarding VSM as an effective tool for eradicating waste in our production facility, 47.6.**% of the total respondents agree it is Very Effective (VE) while 38.0**% of the respondents agree that it is Effective (E). 4.7**% were Neutral (N) while 8.3**% believed that it was Somehow Effective (SE) and 1.1**% said it was Not Effective (NE). 50.0**% of the respondents agreed that

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VSM is a Very Effective (VE) tool for significant change to the production system. 36.9**% agreed it is Effective (E) while 5.9**% and 9.5**% said was Neutral (N) and Somehow Effective (SE) respectively.

IV. Summary of Data Analysis Results

(i). Test of Hypothesis:

We examined the following null hypotheses win this study.

$H0_1$: VSM as a Continuous Improvement (CI) tool does not enhance the Operational Efficiency (OE) of the Innoson Vehicle Manufacturing Company of Nigeria.

$H0_2$: Waste elimination through VSM does not influence the Operational Efficiency (OE) of Innoson Vehicle Manufacturing Company of Nigeria.

Table 4. Model Fitting Information

Model	**-2 Log Likelihood**	**Chi-Square**	**Df**	**Sig.**
Intercept Only	967.521			
Final	935.915	31.606	3	.000
Source: Researcher's Computation (2024) Link function: Logit.				

To analyze the hypothesis, we employed logical regression at 95% intervals. The model fitting information in Table 6 shows the -2 log-likelihood for the intercept-only (or null) model and the final model containing the full set of predictors. The likelihood Chi-Square test is whether there is an improvement in the fit of the final model relative to the intercept-only model. The value of 967.521 is the intercept (outcome values) and the final adjusted predictors' value of 935.915. The difference between the two variables establishes the Chi-Square of 31.606 at a single unit degree of freedom. In this case, since the p-value of .000 is less than the 0.05 threshold, the null hypotheses were rejected. In other words, table 6 shows that there is a significant influence of the baseline model on the final model. The baseline model is without any independent variables and the final model is with all possible independent variables. The model fitting information at a P-value of 0.000 means that the model is a good fit.

Table 5: Pseudo R-Square

Cox and Snell	.264
Nagelkerke	.264
McFadden	.130
Link function: Logit.	

The Pseudo R-square in Table 7 used in ordinal logistic regression explains the rate of change in the regression model. The Nagelkerke test explains the degree of changes as a result of a change in the independent variable. The Nagelkerke test of .264 shows that the 26.4 rate of change in the model is caused by a percentage change in the outcome variables. The Nagelkerke test result is low because I have only one independent variable. If the independent variable is increased to two or three, there a tendency for an increase in the Nagelkerke result.

Table 6: Summary of Ordinal Logistic Regression of the Continuous Improvement (CI) Tool Operational Efficiency of the Innoson Vehicle Manufacturing Company, Nigeria.

Model	-2 Log Likelihood	Chi-Square	Df	Sig.
Intercept	898.571	69.745	19	.000
LOGCI	872.306[a]	43.481	19	.001

$P<0.05$, df 19

The test of hypothesis results in Table 4 shows -2log likelihood model Intercept of 898.571 and LOGCI of 872.306a at Chi-square of 69.741 and 43.481 respectively. The predictor's Chi-square value of 43.481 at 19 degrees of freedom indicates that VSM as a Continuous Improvement (CI) tool was statistically significant at .001 because it is less than the threshold of 0.05. Therefore, the hypothesis that VSM as a Continuous Improvement (CI) tool does not enhance the Operational Efficiency (OE) of the Innoson Vehicle Manufacturing Company in Nigeria was rejected because the result shows a positive influence of CI on the firm's operational efficiency.

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Hypothesis ii: H0$_2$: Waste elimination through VSM does not influence the Operational Efficiency (OE) of Innoson Vehicle Manufacturing Company in Nigeria.

Table 7: Summary of logical regression of VSM as Waste Elimination (WE) Tool for Operational Efficiency of Innoson Vehicle Manufacturing Company

Model	-2 Log Likelihood	Chi-Square	Df	Sig.
Intercept	898.571	69.745	19	.000
LOGWE	860.640[a]	31.814	19	.033

P<0.05, Df 19

Table 5 shows -2log likelihood model Intercept of 898.571 and LOGWE of 860.640a at a Chi-square of 31.814. This indicates that at a significant level of .033, VSM as a waste elimination strategy positively influences the firm's operational efficiency at a threshold of 0.05. Therefore, the hypothesis that VSM as a Waste Elimination tool does not enhance the Operational Efficiency (OE) of the Innoson Vehicle Manufacturing Company was rejected. Hence, there was a positive significant effect of Value Stream Mapping on the firm's operational efficiency.

Table 8: Parameter Estimates

		Estimate	Std. Error	Wald	Df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[OE = 2.92]	5.508	1.926	8.178	1	.004	1.733	9.283
	[OE = 3.50]	6.986	1.892	13.634	1	.000	3.278	10.694
	[OE = 3.75]	7.962	1.913	17.318	1	.000	4.212	11.712
	[OE = 4.08]	9.968	1.946	26.228	1	.000	6.153	13.783
	CI	1.134	.359	9.974	1	.002	.430	1.837
	WE	1.087	.420	6.713	1	.010	.265	1.910
Link function: Logit.								

Interpretation of Results

Summary of data analysis and interpretation of results are presented below Along with the standard errors, Wald values, and p-values that accompany them, Table 6 displays the values of the ordinal logistic regression coefficients and intercepts. The original coordinates are as follows: Continuous improvement, 1.134; waste removal, 1.087; operational efficiency, 9.968; and associated probability value of 0.004. This illustrates that the log probabilities of failing at a higher level of the dependent variable should grow for every unit increase in the independent variable. Any rise in a covariate's positive coefficient value indicates a greater likelihood of falling into a category with a "higher" cumulative outcome. A higher probability of being placed in one of the "upper" cumulative result groups is indicative of a higher coefficient on a factor degree. The parameter estimate table indicates that the variable with the highest coefficient 9.968 and a p-value below the significance level of 0.05 is the most important influencing factor. As a result, all independent variables have probability values less than 0.05.

V. Discussion of Major Findings

Concerning VSM as a Continuous Improvement (CI) tool for operational efficiency, the test of estimate shows a significant result of 0.002, with a Wald value of 9.974 and a coefficient of 1.134, a one-unit increase in continuous improvement caused an increase in the log odds of being in a higher level of operational efficiency (OE=4.08). The findings in this study are related to the results by Sakhardande (2011) that lean tools such as VSM, kaizen, and total quality tools are most crucial for implementing lean production. There is also a link between these results and the one by Vasconcelos, F. L. *et al.*, (2020) and Singh, *et al* (2011). According to Singh, *et al* (2011), wastes of Work-In-Process (W.I.P.) inventory, product lead time, station cycle time, and change-over time waste were drastically minimised through Value Stream Mapping (VSM). At the 5% significant level, continuous improvement is statistically significant at 0.002. Waste elimination is demonstrated to be a 0.01 p-value. The results are also in consonant with the findings by Nowak, *et al.* (2017, and Pokuaa and Nadarajah's (2020) study on Visual Stream Mapping (VSM) as one of the lean tools for ensuring information flow and removing the excess. The influence of a factor level on the reference categories determines the sign of the level's coefficient.

VI. Conclusion

This study has evaluated succinctly the connection between Value Stream Mapping and operational efficiency in Innoson Automobile Company of Nigeria. Business organizations can identify flaws in processes, and raw materials handling and improve upon an existing supply chain using flowcharts, the Ishikawa tool (fishbone diagram), visual real-life presentation, and kaizen

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methodology. The VSM is vital for implementing lean manufacturing because it fills the gap that exists between processes, tools, employees, reporting and results. It facilitates clear and concise discussions between the factory and executives regarding lean viewpoints, along with actual information and material flow. Value stream mapping performance is demonstrated when a team walks through an assembly procedure, interacts with staff members, and watches how what is produced evolves from a starting point (inputs) to an end item (output).

This study has evaluated the role of VSM as a continuous improvement tool. The results show that continuous improvement leads to operational efficiency in the study company at a p-value of .002 (below the threshold of 0.05). This means that value stream mapping aided continuous improvement in an organisation which eventually led to operational efficiency. The results also show waste deduction in organisations through VSM. To achieve operational efficiency, businesses must minimise waste of processes, raw materials, time and space. Value stream mapping helped the managers to visualise more than just the single-process level, enabling the corporate heads to view job flow across all processes. In summary, visual stream mapping is the blueprint for production improvement. We recommended that business organisations, government institutions, and non-governmental bodies should apply VSM for implementing plans and actions.

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