



The Implementation of Lean Six Sigma Techniques: Effect on Customer Satisfaction and Retention in Manufacturing Industries in Lagos State, Nigeria

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Abstract: Lean Six Sigma concept emerged for waste elimination and continuous improvement. Manufacturing industries have tried to implement these techniques all over the world. The purpose of this research is to review the implementation of Lean Six Sigma techniques and their effects on customer satisfaction and retention in manufacturing industries in Lagos State, Nigeria. A descriptive case study was conducted in 64 selected regional manufacturing industries. A structured questionnaire was used to collect the data. The findings show that Kanban is the technique that is mostly used by these manufacturing industries. It also proved that strong significant relationships exist between Lean Six Sigma techniques and customer satisfaction and as well as customers retention. Manufacturing organizations should effectively adopt the usage of this technique to attain customer satisfaction, customer retention, continuous quality improvement, profit maximization, cost reduction, and waste elimination.

Keywords: Lean Six Sigma, Nigeria, cost reduction, customer retention, customer satisfaction

Introduction

Nowadays, as business competition intensifies, there is a need for product development and for manufacturing establishments to grow more productive and resourceful [1]. Customer satisfaction and retention are important factors in business success across various manufacturing industries [2]. Customer satisfaction is crucial for business success, acting as a catalyst for customer retention, growth, and profitability [3]. Manufacturing firms that prioritize customer satisfaction as a corporate strategy tend to share similar characteristics, even if they do not consistently excel in market share or valuation [4]. A conceptual model for assessing customer satisfaction in manufacturing industries includes five dimensions: cost and utility, quality and innovation, service and support, corporate image, and customer retention [5]. To enhance customer satisfaction, manufacturing industries should focus on advertising, brand reputation, product features, and after-sales service [3]. Lean Six Sigma (LSS) is becoming essential for continuous quality improvement, Customer satisfaction, and retention in the manufacturing sector, particularly in advanced countries. Effective implementation of this process leads to customer satisfaction and retention in a manufacturing firm [6]. Lean Six Sigma (LSS) combines Lean techniques, which are aimed at waste reduction, with Six Sigma methodologies focusing on reducing process variability. To this effect, companies now trend strategies for continuous improvements in the quality of their products to retain customers to gain market share [7].

Moreover, globalization has opened up an international market for manufacturing companies in Nigeria but has introduced competition in the global market [8]. However, these developed companies in Lagos State Nigeria compete to lure new consumers inside and outside their region. And these steered sundries to adopt the Lean Six Sigma procedure [9]. There are several works reported on the use of Lean Six Sigma by different authors which are not limited to the manufacturing sector. Adeodu *et al.* implemented Lean Six Sigma for production process optimization in a paper production company [10]. Gupta *et al.* worked on Six-Sigma Application in Tire Manufacturing Company: A Case Study [11]. Sunder *et al.* worked on Lean Six Sigma in Consumer Banking: An Empirical Inquiry [7]. Roriz *et al.* investigated Lean implemented in the public sector of Norwegian municipalities as a management tool for improving productivity and performance [12]. Chiarini analysed the use of Lean Six Sigma as a technique for risk management and cost reduction of cancer drugs in health services [13]. Furterer and Elshennawy also implemented Lean Six Sigma in a similar health sector to reduce linen loss in an acute care hospital [14]. Hence, this present study is focused on the implementation of lean Six Sigma techniques: effect on customer satisfaction and retention in manufacturing industries in Lagos State, Nigeria.

Problem statement and hypotheses

Currently, the manufacturing setting is a vigorous one with greater expectations placed on these industries by their customers. Customer satisfaction and retention are some of the major reasons a manufacturing company is involved in production. Globalization has opened up an international market for manufacturing companies in Nigeria but has introduced competition in the global market. However, these developed companies in Lagos State Nigeria compete to lure new consumers inside and outside their region. These steered sundries to adopt the Lean Six Sigma procedure. These firms experience such competition and in other to compete favorably Lean Six Sigma techniques are employed. Moreover, it is very difficult to determine the manufacturing firm that uses Lean Six Sigma and those that still use other techniques. The impact of the usage of these techniques on customer satisfaction and patronage

can barely be differentiated. This work is aimed at assessing Lean Six Sigma techniques in manufacturing industries in Lagos State, Nigeria. The major objective remains to determine the Lean Six Sigma technique that is mostly used in manufacturing industries in Lagos State, Nigeria. Subsidiary objectives are: (1) To determine the relationship between LSS techniques and customer satisfaction in manufacturing companies in Lagos State, Nigeria, and (2) To determine the relationship between LSS techniques and customer retention in manufacturing industries in Lagos State, Nigeria. The subsequent research questions were responded to after this research; **RQ₁**: Which of the Lean Six Sigma techniques is mostly implemented in manufacturing industries in Lagos State, Nigeria? **RQ₂**: What is the connection between Lean Six Sigma techniques and customer satisfaction in manufacturing industries in Lagos State, Nigeria? **RQ₃**: What is the connection between Lean Six Sigma techniques and customer retention in manufacturing industries in Lagos State, Nigeria? The hypotheses of this investigation are shown below: **H0₁**: Lean Six Sigma techniques implementation has not significantly influenced customer satisfaction in manufacturing industries in Lagos State, Nigeria, **H0₂**: Lean Six Sigma techniques implementation has not significantly influenced customer retention in manufacturing industries Lagos State, Nigeria.

The research helps in providing clues into Lean Six Sigma techniques and their application in Lagos State, Nigeria. It also entails the relationship between LSS techniques, customer satisfaction, and retention. The outcome of this study will assist in decision-making on the implementation of LSS techniques in manufacturing industries in Lagos State, Nigeria, and outside the region.

Materials and Methods

Study area

The study was carried out in manufacturing industries Lagos State, Nigeria. It is a state in southwestern Nigeria. Of the 36 Nigerian states, it is the second most populous state but the smallest in area. Geographically, Lagos State is dominated by bodies of water with nearly a quarter of the state's area being bodies of water. Lagos State has been inhabited for years by various indigenous ethnic groups, primarily the majority Yoruba people that live throughout the state but also the Ewe and Ogu peoples in the far west.

Research design/strategy

The analytical technique for this research was a quantitative survey method. Kumar sees quantitative research as research wherein numeric evidence is collected and measurably ascertained [15]. A well-organized approach was used to scrutinize a few issued literatures concerning Lean Six Sigma techniques on or after a well-recognized study database as the edition of the technique used by some researchers [16, 17]. This method is widely used for piloting management research and attaining data about perceptions, ideas, and attitudes of employees toward a given idea. The data unruffled from the respondents aids in responding to the research questions and solving the hypothesis. This work is designed in such a way that it has dependent and independent variables. The equation can be shown as $y = x_1 + x_2$. The dependent variable is the Lean Six Sigma techniques (y), while the independent variable is customer satisfaction (x_1) and customers retention (x_2). On behalf of the hypothesis of this study, absolute values of 1 confirm a perfect linear relationship between each variable. A correlation value close to 0 confirms no linear relationship between each variable.

Data collection procedure

In this research, an investigation research method which is one of the standard methods for scholars to validate statistical research questions and hypotheses was used in the collection of data from 64 manufacturing companies in Lagos State, Nigeria. An instrument used for the collection of the data is a modification of some scholars [13, 14] questionnaires with Likert scale responses. The questionnaires as shown in the appendix were structured in such a way that the respondents were informed on the type of research, the prospects, and the responsibility of the researchers. The population of this study is made up of 64 manufacturing industries in Lagos State, Nigeria. Although 70 questionnaires were administered and 64 questionnaires were collected. The criteria for the distribution of these questionnaires are that these industries should be manufacturing organizations, have a minimum of 50 employees, and have a well-known structure with a communal setup and department of management teams. The firms were pulled out from the database of the Manufacturing Association of Nigeria (MAN). These responses range from Almost Always Used (AAU), Often Used (OU), Sometimes Used (STU), Seldom Used (SU), Never Used (NU), and also Strongly Disagreed (SD), Disagreed (D), Undecided (U), Agreed (A), and Strongly Agreed (SA) which was numbered from 5 to 1 consecutively.

Data analysis

The data analysis for this study was conducted using the Simple Descriptive Method, Pearson's Product Correlation Analysis (PPMC), and Regression Analysis with Excel. The simple Descriptive Method used in this analysis involves the calculation of the cumulative frequency.

Results and Discussion

Table 1 shows the analysis of the Lean Six Sigma technique that is most used in manufacturing industries in Lagos State, Nigeria. Comprehensive summary of all the data composed from the questionnaire. The descriptive method was used in the analysis where the cumulative frequencies (percentage) were calculated. It can be noted that more than half of the respondents always used Kaban and about 100% implemented Kaban as shown

in Table 1. This high implementation is a result of the awareness of the effective usage of this technique. These industries benefited effectively from the implementation of this technique during decision-making and continuous improvement.

Table 1: Analysis of the Lean Six Sigma technique that is most used in manufacturing industries in Lagos State, Nigeria

| LSS Techniques | Almost Always Used (5) | Often Used (4) | Sometimes Used (3) | Seldom Used (2) | Never Used (1) |
|----------------|---------------------------|-------------------|-----------------------|--------------------|-------------------|
| VSM | 42.2 | 20.3 | 25.0 | 9.4 | 3.1 |
| KAIZEN | 48.4 | 15.6 | 23.4 | 10.9 | 1.6 |
| KABAN | *59.4 | 21.9 | 12.5 | 6.3 | - |
| JIT | 28.1 | 31.3 | 10.9 | 21.9 | 7.8 |
| SMED | 45.3 | 9.4 | 25.0 | 17.2 | 3.1 |
| POKE YOKE | 43.8 | 18.8 | 28.1 | 9.4 | - |
| DMAIC | 31.3 | 25.0 | 28.1 | - | 15.6 |
| JIDOKA | 25.0 | 15.6 | 31.3 | 4.7 | 23.4 |
| 5S | 15.6 | 34.4 | 29.7 | 9.4 | 10.9 |
| FMEA | 31.3 | 9.4 | 46.9 | 12.5 | - |
| FISHBONE | 15.6 | 42.2 | 21.9 | 14.1 | 6.3 |
| DOE | 12.5 | 45.3 | 25.0 | 14.1 | 3.1 |
| SPC | 37.5 | 17.2 | 23.4 | 14.1 | 7.8 |
| HEIJUNKA | 14.1 | 21.9 | 28.1 | 3.1 | 32.8 |
| QFG | 28.1 | 18.8 | 32.8 | 7.8 | 12.5 |
| STANDARD | 40.6 | 17.2 | 12.5 | 14.1 | 15.6 |
| TPM | 29.7 | 18.8 | 25.0 | 17.2 | 9.4 |

Source: Fieldwork (2020)

Hypothesis 1: Lean Six Sigma techniques implementation has not significantly influenced customer satisfaction in manufacturing industries in Lagos State, Nigeria tested using data as tracked from a total of 64 valid responses received from manufacturing companies in Lagos State, Nigeria. Questionnaires were investigated with the use of the Pearson Product-Moment Correlation (PPMC) and Regression Analysis methods. PPMC analysis is shown Table 2.

The calculated r is 0.953 (98%) at a 5% level of significance, confirming the presence of a strong positive relationship between LSS techniques and customer satisfaction. Therefore hypothesis 1 does not accept the null hypothesis H_0 : Lean Six Sigma techniques implementation has not significantly influenced customer satisfaction in manufacturing industries in Lagos State, Nigeria and at such an alternative (H_1): Lean Six Sigma techniques implementation has significantly influenced customer satisfaction in manufacturing industries in Lagos State, Nigeria is accepted.

Table 2: Correlation calculation of hypothesis 1

| Parameter | Strongly Agreed (SA) | Agreed (A) | Undecided (U) | Disagreed (D) | Strongly Disagreed (SD) | |
|----------------|-------------------------|---------------|------------------|------------------|----------------------------|----------|
| Total Response | 134 | 112 | 64 | 10 | 0 | |
| Average | 27 | 22 | 13 | 2 | 0 | Σ |
| Point (x) | 5 | 4 | 3 | 2 | 1 | 15 |
| Response (y) | 27 | 22 | 13 | 2 | 0 | 64 |
| xy | 135 | 88 | 39 | 4 | 0 | 266 |
| x ² | 25 | 16 | 9 | 4 | 1 | 55 |
| y ² | 729 | 484 | 169 | 4 | 0 | 1386 |

Source: Fieldwork (2020)

$$\begin{aligned}
 r &= \frac{N\sum xy - (\sum x)(\sum y)}{\sqrt{N\sum x^2 - (\sum x)^2} \sqrt{N\sum y^2 - (\sum y)^2}} \\
 &= \frac{5(266) - (15)(64)}{\sqrt{(5 \times 55) - (15)^2} \sqrt{(5 \times 1386) - (64)^2}} \\
 &= \frac{1330 - 960}{\sqrt{(275 - 225)} \sqrt{(6930 - 4096)}} = \frac{370}{\sqrt{(50)(2834)}} \\
 &= \frac{370}{\sqrt{141700}} = \frac{370}{376.43} \\
 r &= 0.9829.
 \end{aligned}$$

Table 3: ANOVA for the regression analysis

| | df | Sum of Squares | Mean Squares | F | Sig. F |
|------------|-------------|----------------|--------------|---------|--------|
| Regression | 1 | 384932.391 | 384932.391 | 406.286 | 0.000 |
| Residual | 62 | 58741.342 | 947.441 | | |
| Total | 63 | 824134.741 | | | |
| Intercept | | | | | |
| 5 | Coefficient | Standard Error | T stat | P value | |
| 4 | -2.305 | 0.840 | -16.464 | 0.004 | |
| | 1.742 | 0.744 | 2.341 | 0.011 | |

Source: Fieldwork (2020)

Furthermore, the ANOVA Table 3 breaks down the components of the variations in the data into variations between its regression and residual error. The P value of the F statistic 406.286 is extremely small. Therefore hypothesis 1 does not accept the null hypothesis H_0 : Lean Six Sigma techniques implementation has not significantly influenced customer satisfaction in manufacturing industries in Lagos State, Nigeria and at such an alternative (H_1): Lean Six Sigma techniques implementation has significantly influenced customer satisfaction in manufacturing industries in Lagos State, Nigeria is accepted.

Hypothesis 2: Lean Six Sigma techniques implementation has not significantly influenced customer retention in manufacturing industries in Lagos State, Nigeria as tracked by 5 questions of the administered questionnaire. 88 valid replies were received and investigated using Pearson product-moment correlation (PPMC) and Regression analysis (excel). With PPMC as shown in Table 4, r is 0.984 (98%) at a 5% significance level which demonstrates the existence of a strong positive association between LSS techniques and customer retention. The alternate hypotheses Lean Six Sigma techniques implementation has significantly influenced customer retention in manufacturing industries in Lagos State, Nigeria is accepted.

Table 4: Calculation of the correlation on Hypothesis 2

| Parameter | Strongly Agreed (SA) | Agreed (A) | Undecided (U) | Disagreed (D) | Strongly Disagreed (SD) | |
|----------------|----------------------|------------|---------------|---------------|-------------------------|----------|
| Total Response | 150 | 102 | 60 | 8 | 0 | Σ |
| Average | 30 | 20 | 12 | 2 | 0 | |
| Point (x) | 5 | 4 | 3 | 2 | 1 | 15 |
| Response (y) | 30 | 20 | 12 | 2 | 0 | 64 |
| xy | 150 | 80 | 36 | 4 | 0 | 270 |
| x^2 | 25 | 16 | 9 | 4 | 1 | 55 |
| y^2 | 900 | 400 | 144 | 4 | 0 | 1448 |

Source: Fieldwork (2020)

$$\begin{aligned}
 r &= \frac{N\sum xy - (\sum x)(\sum y)}{\sqrt{N\sum x^2 - (\sum x)^2} \sqrt{N\sum y^2 - (\sum y)^2}} \\
 &= \frac{5(270) - (15)(64)}{\sqrt{(5 \times 55) - (15)^2} \sqrt{(5 \times 1448) - (64)^2}} \\
 &= \frac{1350 - 960}{\sqrt{(275 - 225)} \sqrt{(7240 - 4096)}} = \frac{390}{\sqrt{(50)(3144)}} \\
 &= \frac{390}{\sqrt{157200}} = \frac{390}{396.48} \\
 r &= 0.9837.
 \end{aligned}$$

Table 5: ANOVA for the regression analysis

| Model | df | Sum of Squares | Mean Squares | F | Sig. F |
|------------|-------------|----------------|--------------|---------|--------|
| Regression | 1 | 284781.327 | 284781.327 | 381.003 | 0.000 |
| Residual | 62 | 46342.114 | 747.452 | | |
| Total | 63 | 378140.148 | | | |
| Intercept | | | | | |
| 5 | Coefficient | Standard Error | T stat. | P value | |
| 4 | -2.463 | 1.155 | -2.132 | 0.018 | |
| | 1.962 | 0.639 | 3.070 | 0.002 | |

Source: Fieldwork (2020)

ANOVA Table 5 above shows a statistical significance of 0.000. The statistical F is larger than the P value. Thus hypotheses 2 does not accept the null hypothesis (H_0) which conditions that no relationship exists between LSS techniques and customer satisfaction in manufacturing industries in Lagos State, Nigeria, and such an alternative is accepted.

Conclusion

This chapter shows the conclusion and the recommendations made in this study. With the significant findings, the current level of Lean Six Sigma implementation in manufacturing industries in Lagos State, Nigeria is examined. It can be concluded that a lot of these industries have implemented manufacturing initiatives to survive in a viable marketplace. Lean Six Sigma is one of these techniques that ensures cost reduction by identifying and eliminating all non-significant-added activities. Kaban accounts for the most used techniques in these manufacturing industries. Its effective usage significantly affects customer satisfaction and retention. And it was proven the existence of a significant relationship between the usage of LSS techniques and customer satisfaction and retention. Therefore, the study recommends that:

- Manufacturing organizations should effectively adopt the usage of this technique to attain customer satisfaction, customer retention, continual quality improvement, profit maximization, cost reduction, and waste elimination.
- Staff of the industries in Lagos State, Nigeria should undertake further training on LSS techniques for its effective implementation.

Acknowledgment: At this point, I wish to thank the Almighty God for that ability and grace to carry out this program successfully. And also, a special thank you to my parents, Engineering Management Department staff and my friends.

Conflict of Interest: There is no conflict of interest.

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