Impact of Quality Control Techniques on Profitability in Manufacturing Organizations

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Abstract- This study seeks to evaluate impact of quality control (QC) techniques on the profitability of Nigerian companies that produce roofing sheets. Structured questionnaires were used to gather primary data from stakeholders in the aluminum roofing sheet manufacturing businesses in Rivers state, Nigeria. Descriptive statistical techniques were then used for the study. The results of multiple linear regression analysis showed a positive relationship between the dependent variable (profitability of the aluminum roofing sheet firm's) and the independent factors (quality control (QC) procedures). The t-test result showed that Process Flowcharting/Control chart, Statistical Quality Control/statistical process control/process capability study and six sigma quality control techniques has significant effect on profitability. The research findings indicated that manufacturing organizations should use quality control techniques, such as Process Flowcharting/Control chart, Statistical Process Control/Statistical Process Control/process capability study, and Six Sigma quality control techniques, in order to enhance operations and boost profitability.

Keywords: Control, Impact, Manufacturing, Organizations Quality, Profitability

I. INTRODUCTION

Quality can be defined as fulfilling specification or customer requirement, without any defect (Nnadi *et al.*, 2018). A product is said to be high in quality if it is functioning as expected and reliable. Quality is an important factor in determining the satisfaction that consumers get after buying and using a product because a good quality product will be able to fulfil the wants and needs of consumers, so companies need to maintain the quality of their products so they can compete with other companies in maintaining satisfaction. According to Al-Aqeeli (2016), offering a quality product that is consistent with customer expectations is done through measures put in advance to produce a distinctive good or service. These measures according to Sarhan, (2012) are a set of ideas, principles and techniques that can be applied by businesses to produce quality goods and achieve the best possible performance and increase their profits. This act is called quality control.

Quality control is the process of inspecting products to ensure that they meet the required standards (Utkarsh, 2020). Quality control is based on inspection and aims to take the defects out. Quality Control (QC) is a system of routine technological activities, to calculate and control the quality of a product as it is being developed. It refers to activities to ensure that produced items are fulfilling the highest possible quality. Quality control is also a process through which industries seek to ensure that the product quality is maintained or improved and manufacturing errors are reduced or eliminated to make profit. Profitability is measured by income and expenses. In business, income means the money generated from business activities and not from non-activities like borrowing and grants (Daniel *et al*., 2018). Measuring profitability is the most important measure of the success of the business. The idea of profitability is the primary goal of all business ventures. Without profitability, the business will not survive in the long run. Horton and Potters describe profitability as a measurement of efficiency and ultimately a measure of the success or failure of a business. They further defined profitability as a business's ability to produce a return on an investment based on its resources in comparison with an alternative investment (Subin & Sudheer, 2008). Manufacturing industries have stressed the importance of producing high-quality products, to improve productivity and profitability.

Quality control techniques are process control practices and tools implemented by manufacturing industries to ensure that efficiency and effectiveness of its operation in terms of providing products and services that are dependable, satisfactory and economical, ensuring economic production of products and delivery of services of uniform quality acceptable to the customer and preventing the occurrence of defective products or services (Daniel *et al*., 2018). Quality control techniques can be classified into basic, intermediate, and advance level, but there is no consensus among researchers in the classification. They include quality at the source, inspection, statistical quality control (SQC), quality circle and total quality management (TQM). A variety of other techniques practices exist to control the products or process quality such as top-level management dedication and backing, training, no defects, employee focus, empowerment and involvement, benchmarking, supplier relations, customer focus and emphasis, quality measurement and use of statistical procedures (Daniel *et al*., 2018). Most of tools and techniques to control quality are statistical techniques. Statistical Quality Control (SQC) or Statistical Process Control (SPC) is a process control tool that is often used to determine process variability on control charts

along with process capability analysis (Lestari, 2018). Statistical methods are needed to understand the variability in product and process variables. In addition, the use of statistical methods can also minimize the variability that directly affects product quality. Statistical process control (SPC) tools include: plan, do, check, act (PDCA), quality function deployment (QFD), acceptance sampling, failure mode and effects analysis (FMEA), a design of experiments (DoE) and Six-sigma (Atul *et al.,* 2017).

Several studies show that a lot of attention has been paid to the problem of investigating the impact of quality control techniques on the profitability of manufacturing organizations. Many authors are professionally engaged in quality control and the performance of small and medium scale enterprises in Southwestern Nigeria, the impact of quality practices on productivity and profitability in the Saudi Arabian Dried Date Industry, as well as an empirical analysis of quality control techniques and product quality in manufacturing firms in South East Nigeria, (Osuolale *et al.*, 2018; Abdulrahman, 2013; Nnadi *et al.*, 2018). Prístavka *et al.* (2016) investigated quality control in production processes while Tarba (2016) analyzed quality control methods and tools for improvement of effectiveness of manufacturing processes and Deepak (2016) studied application of quality control tools in a bicycle industry: a case study. Singh and Khan (2012) studied tools and techniques for quality management in manufacturing industries. Subedi and Maheshwari (2007) assessed the impact of total quality management (TQM) on profitability and efficiency of Baldridge Award winners. Lakhal *et al.* (2006) studied quality management practices and their impact on performance while Su *et al.* (2008) investigated the impacts of quality management practices on business performance-an empirical investigation from China and Mutua (2014) evaluated quality management practices and financial performance of cement manufacturing firms in Kenya. These studies, however, addressed the problem of investigating the impact of quality control techniques on the profitability of manufacturing organizations, but in a restricted manner.

In this research, the various quality control techniques applied in Aluminum manufacturing organizations and the degree at which the quality control techniques are applied in the manufacturing organizations were assessed, and the impact of the applied quality control techniques on the profitability of the manufacturing organizations was investigated. The correlation between the applied quality control techniques and the profitability of the manufacturing organizations was evaluated. Ultimately, a regression model that indicates the extent to which the applied quality controls techniques influence profitability of the manufacturing organizations was generated and analyzed.

II. MATERIALS AND METHODS

The materials that were used for this study are primary data that was collected using structured questionnaires and semi structured interviews, designed to elicit specific responses for qualitative and quantitative analysis respectively from a sample of stakeholders in the aluminum roofing sheet manufacturing industries in Rivers State. This category of the respondents was chosen because they are deemed to understand the implementation quality control in manufacturing process of aluminum.

For the purpose of this study, all the information presented is factual, substantiated by the nature of face-to-face pre-interviews, respondents' opinions expressed in the preliminary pre-testing amongst a purposive sample of organization. To ensure that the reliability and the consistency of the data for the study, reliability test was carried out on the data received from the responses to the questionnaires disseminated. The Cronbach's alpha for the scales of employee performance are at an acceptable level of reliability averaging 0.92. The scales used are considered reliable and valid for the research study (see Table 1).

The collected data was analyzed using statistical package for social sciences (SPSS). The collated data was edited to ensure that it was free of errors. Editing was also necessary to ensure easy capturing into the SPSS software. Each questionnaire was evaluated and counted to ensure that all required fields were properly answered by the respondents. Five-point Likert scale was employed to investigate the extent to which quality control techniques are applied in the manufacturing organisation. Ranging from 1 = "Very small extent", 2 = "Small extent", 3 = "Moderate extent", 4 = "Large extent" and 5 = "Very large extent." The scores of "Very small extents" and "Small extent" have been in use to symbolise a variable of a mean score of 0 to 2.5 on the continuous Likert scale; (0≤ S.E <2.4). Also, the scores of "moderate extents" represent a variable with a mean score of 2.5 to 3.4 on the continuous Likert scale: (2.5≤M.E. <3.4) and finally, the scores of both "Great extent" and "Very great extent" represents a mean score of 3.5 to 5.0 on a continuous Likert scale; (3.5≤ L.E. <5.0).

Pearson Product Moment Correlation Coefficient

The Pearson Product Moment Correlation coefficient is a statistical tool that measures the strength between variables and relationships (Miles & Huberman, 2004). It was used to determine how strong the relationship is between two variables such as the individual quality controls techniques with profitability of the aluminium roofing sheet manufacturing organizations, in Rivers State. The Pearson correlation coefficient (r) is given as (Miles & Huberman, 2004):

$$r = \frac{N\sum xy - (\sum x)(\sum y)}{[N\sum x^2 - (\sum x)^2][N\sum y^2 - (\sum y)^2]} \quad (1)$$

Where,

N	=	number of pairs of scores
Σxy	=	sum of the products of scores
Σx	=	sum of x scores
Σy	=	sum of y scores
Σx^2	=	sum of squared x scores
Σy^2	=	sum of squared y scores

Multiple Regression Analysis

The regression model was developed to establish the relationship and influence of individual quality controls techniques on organizational profitability for aluminum manufacturing organizations in Rivers State, Nigeria. The regression model consists of dependent and independent variable. The quality control techniques (Process Flowcharting/Control chart, Cause & effect diagrams/scatter diagram,/histograms, Pareto analysis, Check sheets, FMEA, Statistical Quality Control/statistical process control/process

capability study, Acceptance sampling, Design of Experiments and Six sigma quality control techniques) as the independent variables of the model attached with regression weights which indicates how much they influence or impact on the dependent variable (profitability of the aluminum roofing sheet manufacturing organizations in Nigeria). Mathematically, the regression model adopted for the data analysis is:

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + e \quad (2)$$

Where:

Y = Profitability of the aluminum roofing sheet manufacturing organizations
b_0 = the Y intercept when x is zero
b_1, b_2, b_3, b_4, b_5, b_6, b_7, b_8 and b_9 are regression weights attached to the variables
$X_1 \ldots X_n$ are the coefficients /indicators
X_1 = Process Flowcharting/Control chart
X_2 = Cause & effect diagrams/scatter diagram/histograms
X_3 = Pareto analysis
X_4 = Check sheets
X_5 = FMEA
X_6 = Statistical Quality Control/statistical process control/process capability study
X_7 = Acceptance sampling
X_8 = Design of Experiments
X_9 = Six sigma
e = Error term.

ANOVA/F-test

The standard regression analysis of variance (ANOVA)/F-test was used to test the significance of the linear models. Mathematically, one way-ANOVA F-test statistic is given by:

$$F = \frac{Explained\ variance}{Unexplained\ variance} \quad (3)$$

T-test

The significance of the independent variables partial slope parameters was ascertained using the standard relevant t-tests. In testing the null hypothesis that the population mean is equal to a specified value μ_0, the test is applied and it is given by:

$$t = \frac{\bar{x} - \mu_0}{s/\sqrt{n}} \quad (4)$$

III. RESULTS AND DISCUSSION

The analysis of retrieved data and discussion of findings from the selected aluminium roofing sheet manufacturing organizations; was covered in this chapter. The survey was conducted to investigate relationship between quality control techniques and profitability of manufacturing organizations in Rivers State, Nigeria, that deal solely on aluminium roofing sheet. Descriptive statistics such as percentages, frequencies, mean and standard deviation were the main units of degree used to present the discoveries. An overall of 100 questionnaires (i.e. 10 questionnaires per company) were distributed and 92 correctly and completely filled and returned. Presenting a response rate of 92%, therefore, the data available was excellent for the study.

Assessing the various Quality Control Techniques applied in Aluminium roofing sheet manufacturing organizations in Nigeria

Based on the first objective of this study being to identify and assess the various quality control techniques applied in Aluminium roofing sheet manufacturing organizations in Nigeria and through an extensive literature review, a total of nine quality control techniques were assessed including: Process flowcharting/Control charts, Cause & effect diagrams/Scatter diagrams/ Histograms, Pareto analysis, Check sheets, FMEA, Statistical Quality Control/ Statistical Process Control/.Process Capability Study, the Acceptance Sampling, Design of Experiments (DoE), and Six Sigma. Five-point Likert scale was employed to assess the various quality control techniques applied in Aluminium roofing sheet manufacturing organizations in Nigeria. Ranging from 1 = "Very small extent", 2 = "Small extent", 3 = "Moderate extent", 4 = "Large extent" and 5 = "Very large extent." The scores of "Very small extents" and "Small extent" have been in use to symbolise a variable of a mean score of 0 to 2.5 on the continuous Likert scale;(0≤ S.E <2.4). Also, the scores of "moderate extents" represent a variable with a mean score of 2.5 to 3.4 on the continuous Likert scale: (2.5≤M.E. <3.4) and finally, the scores of both "Large extent" and "Very large extent" represents a mean score of 3.5 to 5.0 on a continuous Likert scale; (3.5≤ L.E. <5.0).

Table 2 shows the various quality control techniques applied in Aluminium roofing sheet manufacturing organizations in Nigeria analyzed using the mean index analysis.

From the results, Six Sigma, Process flowcharting/Control charts and Statistical Quality Control/ Statistical Process Control/Process Capability Study are the most applied quality control techniques in Aluminium roofing sheet manufacturing organizations in Nigeria. Six Sigma and Process flowcharting/Control charts acquired the highest mean index (3.44), followed by Statistical Quality Control/ Statistical Process Control/Process Capability Study with mean score (3.41) whereas Cause & effect diagrams/Scatter diagrams/ Histograms are the least applied quality control techniques in Aluminium roofing sheet manufacturing organizations in Nigeria mean index (2.82).

Analyzing the extent to which the applied quality controls techniques impact on profitability of the manufacturing organizations.

Determining the extent to which the applied quality controls techniques influence profitability of the manufacturing organizations was the second objective of the research. The quality control techniques applied in manufacturing organizations includes: Process flowcharting/Control charts, Cause & effect diagrams/Scatter diagrams/ Histograms, Pareto analysis, Check sheets, FMEA, Statistical Quality Control/ Statistical Process Control/Process Capability Study, the Acceptance Sampling, Design of Experiments (DoE), and Six Sigma.

Five-point Likert scale was employed to investigate the extent to which the applied quality controls techniques influence profitability of the manufacturing organizations. Ranging from 1 = "Very small extent", 2 = "Small extent", 3 = "Moderate extent", 4 = "Large extent" and 5 = "Very large extent." The scores of "Very small extents" and "Small extent" have been in use to symbolise a variable of a mean score of 0 to 2.5 on the continuous Likert scale;(0≤ S.E <2.4).

Table 2: Assessing the various Quality Control Techniques applied in Aluminium roofing sheet manufacturing organizations in Nigeria.

Quality Control Techniques applied in Aluminium roofing sheet manufacturing organizations in Nigeria	1 (VSE)	2 (SE)	3 (ME)	4 (LE)	5 (VLE)	Total (Σfx)	Mean	Std. Dev.
Process flowcharting/Control charts	14	10	15	27	26	317	3.44	0.80735
Cause & effect diagrams/Scatter diagrams/ Histograms	20	21	18	21	12	260	2.82	0.84580
Pareto analysis	12	17	29	23	11	280	3.04	0.49614
Check sheets	13	19	25	20	15	281	3.05	0.72324
FMEA	10	16	28	25	13	291	3.16	0.92076
Statistical Quality Control/ Statistical Process Control/.Process Capability Study	15	8	22	18	29	314	3.41	0.79703
Acceptance Sampling	19	20	21	17	15	265	2.88	0.93918
Design of Experiments (DoE),	18	21	18	19	16	270	2.93	0.83359
Six Sigma	15	10	15	23	29	317	3.44	0.87376

Source: Research Survey, 2024

Also, the scores of "moderate extents" represent a variable with a mean score of 2.5 to 3.4 on the continuous Likert scale: (2.5≤M.E. <3.4) and finally, the scores of both "Large extent" and "Very large extent" represents a mean score of 3.5 to 5.0 on a continuous Likert scale; (3.5≤ L.E. <5.0).

From the outcome of the results in Table 3, it is revealed that the quality control techniques have been carried out generously by the sampled manufacturing organizations. From data brought together, it was revealed by respondents that Process flowcharting/Control charts quality control technique is practiced between a very large extent and large extent. Major activities in Process flowcharting/Control charts quality control technique are accomplished to a large extent (Learn the current process operation and conduct objective analysis, to identify problems and weaknesses, Effective elimination of unnecessary steps or duplication and the objective of the improvement effort, Constant innovation to improve work processes, and Organization focuses more on process improvement) made known by mean scores of 4.0769, 3.9500, 3.9000 and 3.7000 respectively. All other activities demonstrate that Cause & effect diagrams/Scatter diagrams/ Histograms quality control techniques have been institutionalised in the various organizations at large extent (Logically organizes possible causes for a specific problem or effect by graphically displaying them in increasing detail, Organization focuses to see how each cause relates to the effect, thereby measuring and eliminates wastes, elimination of waste and improving efficiency, and Measure and improves high volume production processes) by a mean score of 3.9250, 3.8000, 3.6500, and 3.6250 respectively. Every other activities display that Pareto analysis quality control technique reveals that it has been institutionalised by various organizations at large and moderate extent (Quickly identify what business issues need attention, data-driven methodology for eradicating defects, Requirements and recommendations to how management operations work, Standards define, establish and maintain a quality assurance system, and Standards that cover all aspects of organizational activities) made known with a mean between 3.8250, 3.4000, 3.7500, and 3.4750 respectively. All activities in Check sheets quality control technique indicate very large/large extent implementation with a mean of 3.9 and 3.5. Most activities of FMEA quality control technique also displays large and moderate extent implementation by various organisation, deduced with a mean between 3.6 and 3.4. Likewise, activities in Statistical Quality Control/Statistical Process Control/Process Capability Study quality control technique indicate implementation at large extent by various organizations with a mean range of 3.9 to 3.8. Acceptance sampling quality control technique activities reveal that it has been applied at large extent with a mean of 3.7 and 3.6. Activities in Design of Experiments quality control technique indicate application at both moderate and large extent by respective organizations with a mean ranging between 3.6 and 3.3. In the same way, all the activities of Six Sigma quality control technique also reveal very large extent implementation by the respectively organizations. This is shown by a mean of 3.95 to 3.9; see results tabulated in Table 3.

Activities for profitability of manufacturing organizations reveal large extent implementation by the respectively organizations. This is shown by a mean of 3.95 to 3.5. The results point out that Aluminium roofing sheet manufacturing organizations in Nigeria have been practicing quality control technique at a large extent, consequently, improving both sales and supply performance and largely impacting on the

organizations' profitability. This result agrees with Atul *et al.* (2017), that with the help of different kinds of quality control techniques like check sheets, brainstorming, cause and effect diagram, nominal group technique, flow chart, pareto analysis, control chart, statistical process control, the root cause of defect wise and part wise rejection of the product is determined. And these techniques maximize the quality of product and minimize the rejection. Likewise, the outcomes confirm the results from research conducted by Ramesh *et al.* (2019), that quality control tools such as FMEA are utilized to reduce the number of defects in the process that procures significant improvement in the overall Productivity of the Company.

Multiple regression analysis was performed in determining the extent to which the applied quality controls techniques influence profitability of the manufacturing organizations. The regression model was developed to establish the relationship and impact of individual quality controls techniques on organizational profitability for aluminium manufacturing organizations in Rivers State, Nigeria. The regression model consists of dependent and independent variable. The quality control techniques (Process Flowcharting/Control chart, Cause & effect diagrams/scatter diagram,/histograms, Pareto analysis, Check sheets, FMEA, Statistical Quality Control/statistical process control/process capability study, Acceptance sampling, Design of Experiments and Six sigma quality control techniques) as the independent variables of the model attached with regression weights which indicates how much they influence or impact on the dependent variable (profitability of the aluminium roofing sheet manufacturing organizations in Nigeria) (See Table 4).

Dependent Variable: Organizational Profitability

As per the SPSS generated table above, the regression model is:

$$Y = 0.1 + 0.228X_1 + 0.217X_2 + 0.151X_3 + 0.194X_4 + 0.186X_5 + 0.226X_6 + 0.198X_7 + 0.162X_8 + 0.228X_9$$

The multiple linear regression model indicates that all the independent variables have positive coefficient. The regression results above reveal that there is a positive relationship between dependent variable (Organizational Profitability) and independent variables (Process Flowcharting/Control chart, Cause & effect diagrams/scatter diagram, /histograms, Pareto analysis, Check sheets, FMEA, Statistical Quality Control/statistical process control/process capability study, Acceptance sampling, Design of Experiments and Six sigma quality control techniques). From the findings, one unit change in Process Flowcharting/Control chart quality control technique results to 0.228 units increase in Organizational Profitability. One unit change in Cause & effect diagrams/scatter diagram, /histograms quality control technique results to 0.217 units increase in Organizational Profitability. One unit change in Pareto analysis quality control technique, results to 0.151 units increase in Organizational Profitability. One unit change in Check sheets quality control technique, results to 0.194 units increase in Organizational Profitability. One unit change in FMEA quality control technique, results to 0.186 units increase in Organizational Profitability.

Similarly, one unit change in Statistical Quality Control/statistical process control/process capability study quality control technique results to 0.226 units increase in Organizational Profitability. One unit change in Acceptance sampling quality control technique, results to 0.198 units increase in Organizational Profitability. One unit change in Design of Experiments quality control technique, results to 0.162 units increase in Organizational Profitability. Similarly, one unit change in Six sigma quality control technique results to 0.228 units increase in Organizational Profitability. The significant values represented by p 3 are all < 5% (from 0.06 – 0.37) hence this implies that only three of them are the predictors used which were significant. Similarly, the sample used Z-statistic represented by **t** since it is more than 30. Three of the **t** values are > 1.96 hence only three values are significant (Process Flowcharting/Control chart, Statistical Quality Control/statistical process control/process capability study and Six sigma quality control techniques).

These findings are coherent with a study conducted by Ramesh *et al.* (2019) has provided evidence of an existing relationship between quality control techniques and financial performance of manufacturing firms and the effectiveness of the application of quality control techniques. However, the study aligns also with study by Kifordu *et al.* (2023) that the effect of quality control techniques on financial performance can be directly measured due to their direct relationship.

Determining the correlation between quality control techniques applied in Aluminium roofing sheet manufacturing organizations in Nigeria and the profitability of the manufacturing organizations.

The correlation between quality control techniques applied in Aluminium roofing sheet manufacturing organizations in Nigeria and the profitability of the manufacturing organizations was determined. The result from Table 5 shows that the correlation coefficient (R) between the applied quality control techniques and profitability of Aluminium roofing sheet manufacturing organizations is 0.983. Table 5 also shows that the coefficient of determination between the quality control techniques applied in Aluminium roofing sheet manufacturing organizations in Nigeria and the profitability of the manufacturing organizations was 0.965. This shows that a very strong positive relationship exists between quality control techniques and profitability in n Aluminium roofing sheet manufacturing organizations in Nigeria.

ANOVA/F-test

The standard regression analysis of variance (ANOVA)/F-test was used to test the significance of the linear models.

Table 6: Analysis of Variance (ANOVA)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	5.753	6	0.9589	15.316	0.000[b]
	Residual	2.066	33	0.063		
	Total	7.819	39			

Source: Research Data, 2024

Table 3: Extent to which the applied quality controls techniques impacts on profitability of the manufacturing organizations

Quality controls techniques	Mean	Std. Deviation
Process flowcharting/Control charts		
Learn the current process operation and conduct objective analysis, to identify problems and weaknesses	4.0769	0.80735
Effective elimination of unnecessary steps or duplication and the objective of the improvement effort	3.9500	0.84580
Constant innovation to improve work processes	3.9000	0.49614
Organization focuses more on process improvement	3.7000	0.72324
Cause & effect diagrams/Scatter diagrams/ Histograms		
Logically organizes possible causes for a specific problem or effect by graphically displaying them in increasing detail.	3.9250	0.79703
Organization focuses to see how each cause relates to the effect, thereby measuring and eliminates wastes	3.8000	0.93918
Elimination of waste and increasing efficiency	3.6500	0.83359
Measure and improves high volume production processes	3.6250	0.89693
Pareto analysis		
Quickly identify what business issues need attention, data-driven methodology for eradicating defects	3.8250	0.87376
Requirements and recommendations to how management operations work	3.4000	0.88289
Standards define, establish and maintain a quality assurance system	3.7500	0.86972
Standards that cover all aspects of organizational activities	3.4750	0.82858
Check sheets		
Structured table created by tallying each type of defect for a specified time	3.9250	0.85896
Time and effort to eliminate wasteful or unnecessary steps	3.7500	0.74248
Just-in-time to focus on rapid throughput	3.6579	0.93798
Organization focuses on defects and how many time each type of defect occurred during that period for process improvement	3.5250	1.10911
FMEA		
Systematic, proactive method for evaluating a process to identify where and how it might fail	3.6250	0.83781
Assess the relative impact of different failures	3.5250	0.84694
Identify the parts of the process that are most in need of change	3.4872	0.85446
Maintenance of defective part of the process and increasing efficiency	3.3750	1.00480

Statistical Quality Control/ Statistical Process Control/.Process Capability Study		
Statistical process control to indicate that how a process changes over time.	3.9500	0.74248
Inspecting process to meet quality standards	3.9250	1.01242
Organization determine whether or not a process is operating consistently or if special cause has occurred to change process mean or variance	3.8250	0.93336
Organization focuses on statistical controls to enhance production	3.9250	1.06187
Acceptance Sampling		
Measurement Of Data And Showing A Distribution Of Variables Or Cause Of Problems	3.7250	0.85896
Sampling and eliminating wasteful or unnecessary steps	3.7500	0.74248
Perform quality checks after all operations have been performed to prevent defective products from getting to the market/consumers.	3.7000	0.82275
Focus on rapid thorough process enhanced	3.6579	0.93798
Design of Experiments (DoE)		
Analyzing customer choices in order to determine value of lean	3.6250	0.83781
Improved quality of products through DoE quality control leads to increased customer's satisfaction	3.5250	0.84694
Continuous comparison of results with competitors	3.4872	0.85446
Measuring and continuous comparing itself against business leaders	3.3750	1.00480
Six Sigma		
Our quality control measures have decreased the number of products defects, errors, and failures found by our customer	3.9500	0.74248
Organization focuses on the raw materials and machines and equipment used in the production process for quality worthiness	3.9270	0.01242
Through our quality control technique, our products are always conforming with customers' tastes and demand	3.9000	0.93336
Due to quality control measures, our products are not returned by customers after purchase, we have lesser complaints about product	3.9250	0.06187
Profitability of the Manufacturing Organizations	**Mean**	**Std. Deviation**
Improved quality of products through quality control leads to increased organization profitability and satisfaction	3.9500	0.84580
The organization believes that improved quality of products through quality control could increase the productivity and profitability of the system	3.9000	0.49614
The production focuses on Improved quality of products through quality control techniques	3.7000	0.72324
Poor application of quality control techniques in production has a huge impact on the organization in terms of cost and output	3.5250	0.84694

Table 4: Tests of Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	0.100	0.124		0.811	0.423
Process Flowcharting/Control chart (X1)	0.228	0.079	0.216	2.844	0.008
Cause & effect diagrams/scatter diagram,/histograms (X2)	0.217	0.073	0.202	1.929	0.006
Pareto analysis (X3)	0.151	0.065	0.064	1.082	0.287
Check sheets (X4)	0.194	0.101	0.191	1.930	0.062
FMEA (X5)	0.186	0.083	0.151	1.927	0.063
Statistical Quality Control/statistical process control/process capability study (X6)	0.226	0.105	0.237	2.170	0.037
Acceptance sampling (X7)	0.198	0.101	0.191	1.930	0.062
Design of Experiments (X8)	0.162	0.083	0.151	1.927	0.063
Six sigma (X9)	0.228	0.105	0.237	2.170	0.037

Table 5: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.983a	0.965	0.959	0.25021

Source: Research Data, 2024

Table 6 reveals that the F calculated at 5% level of significance was 15.316 and since F calculated is greater than the F critical (value = 2.17), this shows that the overall model was significant. The F significance value of 0.00 indicates that regression model has probability of 0% of giving wrong prediction. It can be concluded that regression model is statistically significant, hence suitable for explaining how quality control techniques impact on the profitability of the manufacturing organizations.

The whole independent variables have positive coefficient indicated by the multiple linear regression models. Also, the outcome of the regression above shows a positive relationship between dependent variable (Organizational Profitability) and independent variables (Process Flowcharting/Control chart, Cause & effect diagrams/scatter diagram/histograms, Pareto analysis, Check sheets, FMEA, Statistical Quality Control/statistical process control/process capability study, Acceptance sampling, Design of Experiments and Six sigma quality control techniques). From the outcomes, a unit change in Process Flowcharting/Control chart quality control technique results to 0.228 units increase in Organizational Profitability. A unit change in Cause & effect diagrams/scatter diagram/histograms quality control technique results to 0.217 units increase in Organizational Profitability. A unit change in Pareto analysis quality control technique, results to 0.151 units increase in Organizational Profitability. A unit change in Check sheets quality control technique, results to 0.194 units increase in Organizational Profitability. A unit change in FMEA quality control technique, results to 0.186 units increase in Organizational Profitability. Similarly, a unit change in Statistical Quality Control/statistical process control/process capability study quality control technique results to 0.226 units increase in Organizational Profitability. A unit change in Acceptance sampling quality control technique, results to 0.198 units increase in Organizational Profitability. A unit change in Design of Experiments quality control technique, results to 0.162 units increase in Organizational Profitability. Similarly, a unit change in Six sigma quality control technique results to 0.228 units increase in Organizational Profitability. The significant values represented by p3 are all < 5% (from 0.06 – 0.37) hence this implies that only three of them are the predictors used which were significant. Similarly, the sample used Z-statistic represented by t since it is more than 30. Three of the t values are > 1.96 hence only three values are significant (Process Flowcharting/Control chart, Statistical Quality Control/statistical process control/process capability study and Six sigma quality control techniques).
These findings are coherent with results obtained in previous studies (Ramesh *et al*, 2019; Kifordu *et al*., 2023).

IV. CONCLUSION

The aim of this study is to assess the impact of quality control techniques on the profitability of aluminium roofing sheet manufacturing organizations. A regression model forecast tool was used to ascertain the impact of quality control techniques on the profitability of aluminium roofing sheet manufacturing organizations in Nigeria. The outcome of the regression analysis showed that a unit change in Process Flowcharting/Control chart quality control technique results to 0.228 units increase in Organizational Profitability. A unit change in Cause & effect diagrams/scatter diagram/histograms quality control technique results to 0.217 units increase in Organizational Profitability. A unit change in Pareto analysis quality control technique, results to 0.151 units increase in Organizational Profitability. A unit change in Check sheets quality control technique, results to 0.194 units increase in Organizational Profitability. A unit change in FMEA quality control technique, results to 0.186 units increase in Organizational Profitability. Similarly, a unit change in Statistical Quality Control/statistical process control/process capability study quality control technique results to 0.226 units increase in Organizational Profitability. A unit change in Acceptance sampling quality control technique, results to 0.198 units increase in Organizational

Profitability. A unit change in Design of Experiments quality control technique, results to 0.162 units increase in Organizational Profitability. Similarly, a unit change in Six sigma quality control technique results to 0.228 units increase in Organizational Profitability. The significant values (represented by p 3 all < 5% from 0.06 – 0.37) are (Process Flowcharting/Control chart, Statistical Quality Control/statistical process control/process capability study and six sigma quality control techniques).

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