EFFECT OF ADVANCED MANUFACTURING TECHNOLOGY (AMT) ON THE PRODUCT OUTPUT OF MANUFACTURING SMALL AND MEDIUM SCALE ENTERPRISES IN NIGERIA

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ABSTRACT

Manufacturing Small and Medium Enterprises in Nigeria have neither performed credibly well nor played the expected role of contributing significantly to economic growth and development. In recent years, many manufacturing firms have closed down and the existing ones struggle under a myriad of challenges. Several literatures have identified Advanced Manufacturing Technology (AMT) as a key driver for performance of enterprises. There is need to determine if AMT can succeed in enhancing performance of Manufacturing SMEs so as to contribute in revitalizing the economy of Nigeria. The objective of the study was to determine the effect of AMT on the product output of Manufacturing SMEs in Nigeria. This study used descriptive survey research design. The target population for this study consisted of the manufacturing Small Medium Enterprises in Kaduna, Nigeria. The study relied on structured questionnaires as source of primary data which was administered by qualified research team. The researcher employed the paired sample t-test to investigate the existence of any significant differences between the two set of data (before and after adoption). Subsequently, regression analysis and ANOVA was carried out to test the statistical significance of the various independent variables (Computer Aided Design, Computer Aided Manufacturing, Virtual Manufacturing Technology and Computer Numerical control) of AMT on the dependent variable of product output. The findings revealed that Advanced Manufacturing Technology (AMT) have a significant influence on the product output of Manufacturing SMEs in Nigeria confirming the disposition of previous works which present that ATM enables firms to manufacture new and better products more quickly and at a much lower cost than ever before. With dwindling Oil prices as experienced in recent time, the economic system of Nigeria is in precarious situation and calls for diversification. Adoption of Advanced Manufacturing Technology by manufacturing Small Medium Enterprises can enhance performance as well as fast-track the nation's economic development.

Key Words: *Advanced Manufacturing Technology, Product Output, Manufacturing, Enterprises, Computer Aided Design, Computer Aided Manufacturing, Virtual Manufacturing Technology, Computer Numerical Control*

INTRODUCTION

The effective deployment of Advanced Manufacturing Technologies (AMTs) has been widely recognized in recent years as a means of building sustainable competitive advantage and thereby enhancing organizational performance (Koc and Bozdag, 2009). AMTs are defined as technologies concerned with the application of mechanical, electronic, and computer- based systems to operate and control production. It encompasses a range of programmable machinery that executes, monitor, and connect the production process (Lewis and Boyer, 2002). In this

regard, increased requirements for competitiveness, innovation and quality, have led many SMEs to make sizable investments in computer-based manufacturing technologies. The AMTs that are well researched and documented to promote higher output, precision, and profitability are Computer-Aided Design (CAD), Computer- Aided Manufacturing (CAM), Automated Handling (AH), Automated Inspection (AI), Computer Numerical Control (CNC), Automated Packaging (AP), (lin and Chen, 2012).

Cacciolatti, Fearne, and McNeil (2011) indicated that SMEs that make good use of AMT presented a higher earning and growth. The research of Mahmoud (2011) concluded that the higher the level of market orientation, the greater the level of performance in Ghanaian SMEs. There are other empirical evidences from various studies that demonstrate that Advanced Manufacturing Technology (AMT) improves the manufacturing parameters that have significant impact on firm's performance (Koc and Bozdag, 2009).

The application of Computer Aided Design (CAD) as a form of Advanced Manufacturing Technology (AMT) can be found in diverse manufactory industries namely fashion, automobile, and recently food packaging (Marjudi, Suleiman, Amran, Kahar and Abdullahi, 2011, and Okay, 2010). The usage of computers in manufacturing is defined by Computer-Aided-Design which is a process by which the design and analysis of product to be produced is made. Desired design changes are enabled through this method by transferring product to a virtual world with the aid of a computer monitor (Okay, 2010). The common CAD software available to engineers are Autocad, Pro Engineer and Solid Works Program (Collin, Cumming, Dittrich, Jones and Sealey, 2011). In order to realize production, these changes are transmitted as a programme to Computer Numerical Control machines.

Okay (2010); Marjudi et al (2011); Oppong Biney-Aidro and Antiaye (2013) report that productivity efficiency and effectiveness of manufacturing SME's can increase with CAD because the tool is uniquely fast and easy. CAD has also contributed to improvement of quality of design, communication through documentation and creation of database for manufacturing. Other benefits of CAD identified by (Sagar and Nagare, 2012) include reduced product performance risk; enhanced deliveries; cost reduction; enhanced product performance. Studies carried out by Tan and Vonderembse (2006), Oppong et al (2013), and Okay (2010) reveal that CAD usage has a positive impact on product development and cost performance of SME's.

Likewise, the utilization of Computer Aided Manufacturing (CAM) systems is highly effective, because it enables to reduce the process development time and the introduction of a new product in the market. They enable the realization of new product development (including its optimization) without its physical model. CAM has played a major role in achieving a cost effective, quality product by providing a tool to enhance the skills of the designer and engineer (Shaikh, Marri and Irani, 2006). The real payoff in CAD/CAM is linked to its appropriateness as a solution to the problems of decreasing worker productivity and increasing labour costs (Elanchezhian, Sunder and Shanmuga, 2007). It is believed that CAM is a major strategies

adopted by SME's to achieve the productivity gains that will enable them to provide a top quality, cost effective product (Adejuigbe, 2006).

Another key component of AMT is Virtual Manufacturing Technology (VMT) which is seen as an innovation which carries out analysis and research work with digital model instead of practical manufacture. Li and Li (2013) describe the process of Virtual Manufacturing as the mapping of the practical machining in computer virtual environment, no real production is created and without material or power wasting. The essence of adopting VMT is to enhance ability to predict potential problems and inefficiencies in product functionality and manufacturability before real manufacturing occur. (Khan, Cheng and Raoof, 2011). Nikolaos, Markos and Aristomenis (2015) reports that several companies such as Boeing, Chrysler, Mercedes, Renault, Nissan, Food and BMW, employ VMT to verify and analyze production processes in new products development phase and as a result, product development cycle and cost are reduced, product quality is improved, time to market is reduced, number of prototype is reduced and material waste is reduced considerably.

Crucial to Advanced Manufacturing Technology is the CNC machine which is a major part of output of machine tool in advance countries hence vital to manufacturing today (Radhakishnan, Subramanyan and Raju, 2011). Collin et al, (2011) report that adoption of CNC machines by manufacturers is evident from the replacement of conventional machines by CNC machines in many machine shops. Likewise most of the manufacturers of machine tools have switched over to the production of CNC machines from conventional machine tools. To buttress this, it is reported that about 70% of machine tools manufacture in India are CNC machine tools (Radhakishnan et al., 2011). Manufacturing firms have adopted CNC as a strategy to tackle cost factors and increased competition. CNC provides the enabling environment to increase flexibility of manufacturing and expand consumer market. (Koc and Bozdag, 2009) presents that the need for product differentiation has led to acceptance of CNC which makes possible a high degree of variation in product runs and product specialization.

STATEMENT OF THE PROBLEM

Manufacturing Small and Medium Enterprises have not performed credibly well and have not played the expected role in the economic growth and development in Nigeria (Onugu, 2012). In recent years, many manufacturing firms have closed down and the existing ones struggle under a myriad of challenges which have led to lack of patronage of products both in Nigeria and beyond (Onuoha, 2012). Haruna (2013) identified lack of research, innovation and adoption of advanced technology as a major cause that has led to disappearance of some firms and the abysmal performance of existing ones. So many literatures have established positive influence of emerging technologies on performance of enterprise in many manufacturing countries (Subrahmanya, Mathirajan and Karishnaswamy, 2010) .There is need to investigate if technology adoption can enhance performance so as to make informed decisions that will revitalize the manufacturing sector in Nigeria.

RESEARCH OBJECTIVE

The objective of the study was to determine whether Advanced Manufacturing Technology (AMT) affect product output of Manufacturing SMEs in Nigeria.

RESEARCH METHODOLOGY

The research design adopted for this study was descriptive survey. Lavrakas (2008) describes a descriptive survey research design as a systematic research method for collecting data from a representative sample of individuals using instruments composed of closed-ended and/or open-ended questions, observations, and interviews.

Lavrakas (2008) defines a population as any finite or infinite collection of individual elements. According to Zikmund (2010) and Kothari (2004), a population refers to all items in any field of inquiry and is also known as the 'universe'. The population for this study consisted of the manufacturing SMEs in Kaduna, Nigeria. According Gall, Gall and Borg (2007), target population consists of all members of a real or hypothetical set of people events or objects from which a researcher wishes to generalize the results of their research while accessible population consists of all the individuals who realistically could be included in the sample. For the purpose of this study the target population comprised of all 250 Manufacturing SMEs in Kaduna. The coverage included New Pantaka, Kudenda and Nassarawa - Kakuri industrial clusters as a representative sample of the entire SMEs in Nigeria. This study relied on structured questionnaires as a source of primary data which was administered by qualified research team. Schwab (2005) defines questionnaires as measuring instruments that ask individuals to answer a set of questions or respondent to a set of statement.

The study created thematic areas to enable Content Analysis for the qualitative responses. Thereafter, the researcher compared the previous influence before adoption of AMT to the current influence after adoption of AMT. For this purpose, simple Analysis of Variation in the two data sets was carried out. In particular, the researcher employed the paired sample t-test to investigate the existence of any significant differences between the two set of data. By the description of the other objectives, a similar approach was employed at the analysis stage. Accordingly, the researcher used the t-test statistics;

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\frac{\sigma_p^2}{\sqrt{n_1 + n_2}}}$$

and, rejected the set null hypothesis accordingly, at chosen levels of significance α. For the presentations, the researcher employed tables, charts and numerical summaries to report the outcomes. Subsequently, regression analysis and ANOVA was carried out to test the statistical significance of Advanced Manufacturing Technology (AMT) through the various independent

variables (Computer Aided Design (CAD), Computer Aided Manufacturing (CAM), Virtual Manufacturing Technology (VMT), and Computer numerical Control (CNC)) on the dependent variable of Product Output.

RESEARCH FINDINGS AND DISCUSSION

Advanced Manufacturing Technology (AMT) comprising of Computer Aided Design (CAD), Computer Aided Manufacturing (CAM), Virtual Manufacturing Technology (VMT) and Computer Numerical Control (CNC) is the modern manufacturing system utilizing computer for accuracy, consistency and productivity. This study set to determine the extent to which Advanced Manufacturing Technology is adopted in Nigeria. The result portrayed that 65.53% use CAD as a form of AMT, while CAM, VMT and CNC are utilized by 60.98%, 41.95% and 49.44% of manufacturing SMEs respectively. This is illustrated in figure 1.

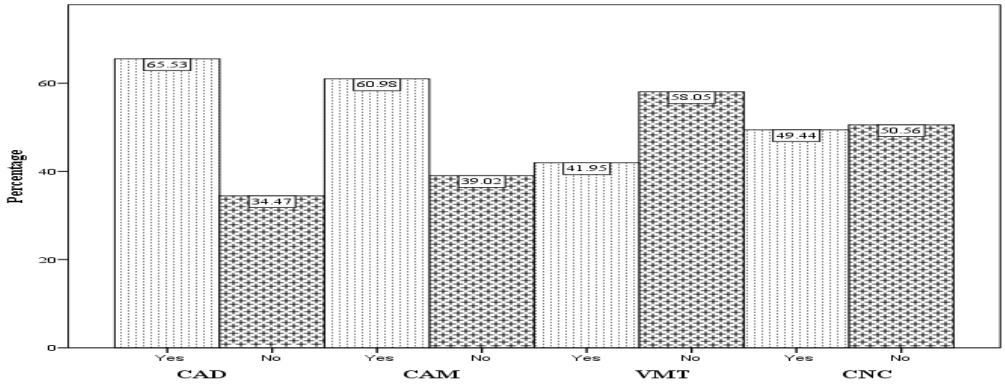

Figure 1: Utilization of Advanced Manufacturing Technology by manufacturing SMEs.

This result corroborates report that the effective deployment of advanced manufacturing technologies (AMTs) has been widely recognized in recent years as a mean of building sustainable competitive advantage and thereby enhancing organizational performance (Koc and Bozdag, 2009). Firms have been encouraged to invest in AMT to realise the benefits to make more contributions to society by improving world standard quality of product (Gunawardana, 2006).

This finding establishes the growing popularity of AMT in Malaysia where in a study carried out in 100 Manufacturing SMEs, firms admitted that AMT is adopted in order to improve efficiency and productivity (Isa and Foong, 2005). This assertion was also stressed by Okay (2010) that the usage of AMT in Turkey has increased significantly with expected benefit being increase in quality, product and productivity.

Its noteworthy that manufacturing leaders such as Germany, Japan, Korea and the United Kingdom and countries whose capabilities have accelerated in the past twenty years such as Brazil and china are committed to maintaining and sustaining AMT as a means to retaining technological superiority (Shipp, Gupta and Lal et al., 2012).

It is therefore inferred that Advanced Manufacturing Technology (AMT) is being adopted extensively by Manufacturing SMEs in Nigeria.

Computer Aided Design (CAD)

This study sought to find out whether Computer Aided Design (CAD) as a component of AMT is adopted by manufacturing SMEs and to what extent it affects their performance. It has been confirmed that 65.53% of the manufacturing SMEs have adopted CAD in their production processes as shown in figure 1. Out of these SMEs 36.9% said that utilization of CAD have resulted to increase in quality and output of their product, 20.4% said utilization of CAD have resulted in time spent in manufacturing process, 14.6% said utilization of CAD has led to accuracy and precision in manufacturing process, while 13.6% and 4.9% confirmed that the use of CAD has led to increase in efficiency and profitability respectively. Reduction cost of labour agreed by 4.8% and flexibility of operation are all present in Table 1.

Table 1: The Effect of CAD on performance of firms

Effect of Using CAD	Percentage
Accuracy and Precision	14.6
Increased Efficiency	13.6
Increased Profitability	4.9
Easy and Cheap Designs	2.9
Increased Quality and Output	36.9
Reduction in Time	20.4
Reduction in Waste	1.0
Reduced Labour cost and Cost of Production	4.8
Flexibility in Manufacturing	1.0
Total	**100.0**

This indicates that Manufacturing firms have identified with CAD to enable them create models of parts and components of what is intended to be manufactured in three dimensions (Collin, et al. 2011). Mohammed, May and Alavi (2008) reinstates previous studies by establishing that CAD compared to traditional design process allows for more time to be used in other aspects of manufacturing production. The consequence of time saving resulting from utilization of CAD can result to incorporation into marketing of product, early delivery of product and development of new products.

It is also in agreement with studies carried out by Tan and Vonderembse (2006), Oppong etal. (2013) and Okay (2010) which revealed that CAD usage has a positive impact on product development and cost performance. It is therefore inferred that CAD as an aspect of AMT can influence performance through increase in quality and output of product, reduction of time spent in manufacturing, improved accuracy and precision and increase in efficiency and profitability. This insinuates a strong positive link between CAD and Performance of manufacturing SMEs in Nigeria.

Computer Aided Manufacturing (CAM)

This study sought to find out whether Computer Aided Manufacturing (CAM) as a component of AMT is adopted by manufacturing SMEs and to what extent it affects their performance. 60.98% of the manufacturing SMEs have adopted CAM in their production processes as shown in figure 1. Table 2 shows that out of these SMEs, 38.2% represents the percentage that said that utilization of CAM have resulted to increase in quality and output of their product, 14.5% said utilization of CAM have resulted in increased efficiency, 13.6% said utilization of CAM has led to accuracy and precision in manufacturing process, 8.2% represent the percentage that said that CAM resulted to reduction in time spent in manufacturing process, 7.3% represent the percentage that said that CAM resulted to reduction in cost of production manufacturing process, 6.4% represent the percentage that said that CAM resulted to reduction in waste generated in manufacturing process, 5.5% represent the percentage that said that CAM resulted to reduced labour cost, 4.5% represent the percentage that said that CAM resulted to reduction in energy utilized in manufacturing process, while 1.1% represent the percentage that said that CAM resulted in flexibility of manufacturing.

Table 2: Effect of Using CAM

Effect of Using CAM	Percentage
Accuracy and precision	13.6
Increased Efficiency	14.5
Increased Quality and Output	38.2
Reduction in Time	8.2
Reduction in Waste	6.4
Reduced Labour cost	5.5
Flexibility in Manufacturing	1.8
Reduction in Cost of production	7.3
Reduction in energy	4.5
Total	**100.0**

This finding corroborates Marri, Gunasekaran, and Grieve, (2000) that the benefits of utilizing CAM includes increased machine use, reduced work-in-process inventory, increased productivity of working capital, reduced labour cost and more consistent product quality amongst others. This also support study in the US by Elanchezhain, Selwyn and Sundar (2015) that the real payoff in CAM is linked to development of cost effective, quality product as well as its appropriateness as a solution to the problems of decreasing worker productivity and increasing labour costs. This also agrees with Radhakishnan, Subramanyan and Raju (2011) that industries use CAM extensively as it is known to help mass customization.

Indeed, this result vindicates Shaikh, Marri and Irani (2006) that the adoption of CAM gives SMEs a greater number of growth options to enter new markets and to create new products than SMEs relying on traditional manufacturing technologies. It is therefore inferred that CAM as an aspect of AMT can influence performance through increase in quality and output of product,

reduction of time spent in manufacturing, improved accuracy and precision and increase in efficiency and profitability. This insinuates a strong positive link between CAM and Performance of manufacturing SMEs in Nigeria.

Virtual Manufacturing Technology (VMT)

This study sought to find out whether Virtual Manufacturing Technology (VMT) as a component of AMT is adopted by manufacturing SMEs and to what extent it affects their performance. It has been confirmed that 58.05% of the manufacturing SMEs have adopted VMT in their production processes as shown in figure 1. Out of these SMEs, 30% represents the percentage that said that utilization of VMT have resulted to reduction in energy, 17.5% said utilization of VMT have resulted in improved decision, 12.5% said utilization of VMT has led to increased efficiency in manufacturing process, 11.3% represent the percentage that said that VMT resulted to easy and cheap designs in manufacturing process, 10% represent the percentage that said that VMT resulted to reduced labour cost in manufacturing process, 3.8% represent the percentage that said that VMT resulted to increased accuracy and precision in manufacturing process, while 1.3% and 1.3% represents the percentage that said that VMT eases work and has no impact respectively. This is shown in Table 3.

Table 3: Effect of Using VMT

Effect of Using VMT	Percentage
Accuracy and precision	3.8
Increased Efficiency and Performance	12.5
Easy and Cheap Designs	11.3
Increased Quality and Output	10.0
Reduction in Time	2.5
Reduced Labour cost	10.0
Reduction in energy	30.0
Eases Work	1.3
No Impact	1.3
Improved decision making	17.5
Total	**100.0**

The findings agrees with Ebrahim, Ahmed and Taha (2015) that competition have driven enterprises to adopt Virtual Manufacturing Technology (VMT) which provides valuable input for new product. This result is in consonance with Nikolaos, Markos and Aristomenis (2015) that reported that several companies such as Boeing, Chrysler, Mercedes, Renault, Nissan, Food and BMW, employ VMT to verify and analyze production processes in new products development phase and as a result, product development cycle and cost are reduced, product quality is improved, time to market is reduced, number of prototype is reduced and material waste is reduced considerably.

This agrees with the expected benefits of VMT which are reduction in material waste, reduction in cost of tooling, higher quality and shorter cycle time (Depince Chablat and Woelk, 2007). The

findings affirms that Virtual Manufacturing play significant role in manufacturing since it leads to improvement in design critiquing and process planning will result in better designs and more informed partner selection (Universidad Nacional de Colombia, 2015). The finding vindicates Li and Zheng (2010) in which VMT was predicted to become an inevitable trend in the development of manufacturing industry in the 21st century. This may be attributed to report that VMT is a capital intensive technology (Depince Chablat and Woelk, 2007).

It is therefore inferred that VMT as an aspect of AMT can influence performance through improved decision making, increase in quality and output of product, reduction of time spent in manufacturing, improved accuracy and precision and increase in efficiency and profitability. This insinuates a strong positive link between VMT and Performance of manufacturing SMEs in Nigeria.

Computer Numerical Control (CNC)

This study sought to find out whether Computer Numerical Control (CNC) as a component of AMT is adopted by manufacturing SMEs and to what extent it affects their performance. It has been confirmed that 49.44% of the manufacturing SMEs have adopted CNC in their production processes as shown in figure 1. Out of these SMEs, 34.4% represents the percentage that said that utilization of CNC have resulted to increased efficiency in manufacturing processes, 25.5% represents the percentage that said that utilization of CNC have resulted to increased accuracy and precision in manufacturing processes, 15.6% said utilization of CNC have resulted in increased quality and output, 11.1% said utilization of CNC has led to increased profitability in manufacturing process, 6.7% represent the percentage that said that CNC resulted to reduction in time in manufacturing process, 3.3% represent the percentage that said that CNC resulted to reduced labour cost in manufacturing process, 1.1% represent the percentage that said that CNC resulted to reduction in waste in manufacturing process, while 1.1% and 1.1% represents the percentage that said that CNC eases work and reduction in cost of production respectively. This is shown in Table 4.

Table 4: Effect of Using CNC

Effect of Using CNC	Percentage
Accuracy and Precision	25.5
Increased Efficiency	34.4
Increased Profitability	11.1
Increased Quality and Output	15.6
Reduction in Time	6.7
Reduction in Waste	1.1
Reduced Labour cost	3.3
Reduction in Cost of production	1.1
Eases Work	1.1
Total	**100.0**

The result corroborates with Kumar (2012) that manufacturing enterprises in India are able to reduce waste thereby improving production rate and productivity following the implementation of CNC machine. This also vindicates Radhakishnan et al. (2011) that manufacturing firms have adopted CNC as a strategy to tackle cost factors and increased competition. CNC provides the enabling environment to increase flexibility of manufacturing and expand consumer market. The findings identifies with result of the study carried out by Krajnak, Baskova and Vojtas (2013) that the implementation of CNC manufacturing have a major impact on return of investment. This emanates from the space created by CNC for improving efficiency of production process compared to traditional method bringing to the fore time savings, material savings and higher quality of product.

In line with the finding is the presentation by Koc and Bozdag (2009) that the need for product differentiation has led to acceptance of CNC which makes possible a high degree of variation in product runs and product specialization. The development of product is achieved at a faster rate, more accurately and with less human effort compared to traditional manufacturing practice (Oduola, Omole, Akinluwade and Adetunji, 2014).

It is therefore inferred that CNC as an aspect of AMT can influence performance through improved decision making, increase in quality and output of product, reduction of time spent in manufacturing, improved accuracy and precision and increase in efficiency and profitability. This insinuates a strong positive link between CNC and Performance of manufacturing SMEs in Nigeria.

T-Test – Product output before and after adoption AMT

T-Test provide for comparisons in mean difference between product output before and after adoption of Advanced Manufacturing Technology (AMT) through its independent variables namely Computer Aided Design (CAD), Computer Aided Manufacturing (CAM), Virtual Manufacturing Technology (VMT) and Computer Numerical Control (CNC). The summary statistics for the findings are displayed in table 5. From the findings, the average output of the product increased from 5.17 to 25.344 after adoption of computer Aided Design (CAD) with standard deviation of 6.77 and 16.11 before and after adoption of CAD. Similarly the average output of product increased from 5.66 to 25.15 after adoption of computer Aided Manufacturing technologies (CAM). Also adoption of VMT and CNC led to increase in average output of the product. See table 5.

In addition to that, Paired sample T-test was also conducted to find out whether there was a significance difference in the mean output of product before and after adoption CAD, CAM, VMT and CNC with confident level of 95%.

Table 5: Paired Samples summery Statistics for AMT

		Mean	N	Std. D	Std. E Mean
Pair1	Product output in tons per month before adoption of CAD	5.17	128	6.77	0.60
	Product output in tons per month after adoption of CAD	25.34	128	16.11	1.42
Pair2	Product output in tons per month before adoption of CAM	5.66	122	7.36	6.67
	Product output in tons per month after adoption of CAM	25.15	122	16.29	1.48
Pair3	Product output in tons per month before adoption of VMT	5.38	86	7.99	0.86
	Product output in tons per month after adoption of VMT	24.26	86	14.47	1.56
Pair4	Product output in tons per month before adoption of CNC	5.48	91	7.65	0.80
	Product output in tons per month after adoption of CNC	28.41	91	16.57	1.74

The result in table 6 shows all the p-values for the four pairs were less than 0.05 thus all the null hypothesis were rejected and the conclusion was that there was significance difference in the mean output of product before and after adoption CAD, CAM, VMT and CNC.

Table 6: Paired Samples test for AMT

		Paired Differences				t	Df	P-values	Decision
	Hypothesis Tested	Mean	Std. D	95% C I Lower	Upper				
Pair 1	$H_0 : \bar{x}_{11} - \bar{x}_{12} = 0$ $H_1 : \bar{x}_{11} - \bar{x}_{12} \neq 0$	-20.17	12.82	-22.41	-17.93	-17.81	127	.000	Reject H_0
Pair 2	$H_0 : \bar{x}_{21} - \bar{x}_{22} = 0$ $H_1 : \bar{x}_{21} - \bar{x}_{22} \neq 0$	-19.49	13.04	-21.83	-17.15	-16.50	121	.000	Reject H_0
Pair 3	$H_0 : \bar{x}_{31} - \bar{x}_{32} = 0$ $H_1 : \bar{x}_{31} - \bar{x}_{32} \neq 0$	-18.88	9.37	-20.89	-16.87	-18.67	85	.000	Reject H_0
Pair 4	$H_0 : \bar{x}_{41} - \bar{x}_{42} = 0$ $H_1 : \bar{x}_{41} - \bar{x}_{42} \neq 0$	-22.92	12.01	-25.42	-20.42	-18.22	90	.000	Reject H_0

$\bar{x}_{11}$=Mean product before adoption of CAD , $\bar{x}_{12}$=Mean product output after adoption of CAD, $\bar{x}_{21}$=Mean Product output before adoption of CAM, $\bar{x}_{22}$ Product output after adoption of CAM, $\bar{x}_{31}$=Mean Product output in before adoption of VMT , $\bar{x}_{32}$ Product output in after adoption of VMT, $\bar{x}_{41}$=Mean Product output before adoption of CNC, $\bar{x}_{42}$ Product output after adoption of CNC.

REGRESSION ANALYSIS

The objective of this study was tested using the null hypothesis which states that: **H_0: Advanced Manufacturing Technology does not influence product output of manufacturing SMEs in Nigeria.** In this analysis, the coefficient of determination 'R^2' and correlation coefficient 'r' shows the degree of association between AMT and product output of Manufacturing SMEs in Nigeria respectively.

The model summary shown in table 7 indicates that the R square was 0.324 suggesting that 32.4% the of the SMEs performance was explained by advanced manufacturing technology before their adoption while R-square value was 0.385 which is 38.5% of SMEs performance explained by AMTs after their adoption. The R-square value indicates how well the model fits the data and it normally ranges between 0.0 to 1.0. An R- square value close to 1.0 indicates that the dependant variable entirely depends on the independent variables while a value close to 0.0 indicates no correlation between the explanatory variables and the dependent variable.

Table 7: Model summary between product turnover of SMEs and AMT

Model	R	R Square	Adjusted R Square	Std. Error
Before AMT	.569	.324	.365	3.32131
After AMT	.621	.385	.371	3.42112

The Analysis of Variance (ANOVA) in table 8 clearly shows that, the p-values were 0.000 before and after adoption of Advanced Manufacturing Technology and all were less than 0.05 thus the null Hypotheses were rejected implying that there was a significant relationship between Advanced Manufacturing Technology and Product Output of SMEs in Nigeria.

Table 8: Analysis of variance before and after adoption of ATMs

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1338.746	1	1338.746	56.233	.000[b]
	Residual	3404.454	143	23.807		
	Total	3943.200	144			
2	Regression	1350.896	1	1350.896	58.479	.000[b]
	Residual	3288.367	143	22.745		
	Total	3639.263	144			

a. Dependent Variable: Product Output of SMEs (Y)

b. Model 1 Predictors AMTs before Adoption and Model 2: Predictors AMTs after Adoption

This finding confirms literature reviewed by Gunawardana (2006) who presented that most firms have achieved some benefits from AMT adoption which cuts across reduced product development time, a need for product change flexibility, increased profitability amongst others.

This result confirms report that the effective deployment of advanced manufacturing technologies (AMTs) has been widely recognized in recent years as a mean of building sustainable competitive advantage and thereby enhancing organizational performance (Koc and Bozdag, 2009). Firms have been encouraged to invest in AMT to realise the benefits to make more contributions to society by improving world standard quality of product (Gunawardana, 2006).

This finding establishes the growing popularity of AMT in Malaysia where in a study carried out in 100 Manufacturing SMEs, firms admitted that AMT is adopted in order to improve efficiency and productivity (Isa and Foong, 2005). The result affirms that by Okay (2010) that the usage of AMT in Turkey has increased significantly with expected benefit being increase in quality, product and productivity.

From the coefficient table 9 we can obtain the two regression models showing the relationship between Product Output of SMEs and AMTs before and after adoption and are expressed as; Y=0.533+ 31.631 X1 and Y=0.214 + 28.950X1. T- Test values also shows that there was significant relationship between the response variable Product Output of SMEs and adoption of ATMs before and after since the p-values were 0.000 < 0.05 for model 1 and 2.

Table 9: Coefficients for Advanced Manufacturing Technology (AMT)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	ATM Before	31.631	2.988		6.849	.000		
		.533	.063	.625	8.872	.000	1.000	1.000
2	ATM After	28.950	1.271		13.027	.000		
		.214	.001	.609	8.475	.000	1.000	1.000

a. Dependent Variable: Performance of SMEs

CONCLUSIONS

The result obtained and analysed revealed that there is significant relationship between Advanced Manufacturing Technology and Performance of manufacturing SMEs. ANOVA clearly showed that the P-Values were 0.000 before and after adoption of Advanced Manufacturing Technology and all were less than 0.05 thus the null hypotheses was rejected. This was corroborated by the regression model sharing relationship and T-test values showing significant relation between response variable performances.

Advanced Manufacturing Technology (AMT) is a modern method of manufacturing incorporating highly automated and convenient computerised designs and manufacturing system. AMT aims at manufacturing high quality, high precision products at low cost within the shortest

delivery time. This study affirms that AMT improves performance and productivity of manufacturing SMEs. It confirms the disposition of previous works which present that ATM enables firms to manufacture new and better products more quickly and at a much lower cost than ever before. It is evident that benefits of AMT as it relates to Computer Aided Design (CAD), Computer Aided Manufacturing (CAM), Virtual Manufacturing Technology (VMT) and Integrated Virtual Private Network cuts across reduction in time, cost and waste; improved product design and quality; higher output; precision as well as profitability.

RECOMMENDATIONS

With dwindling Oil prices as experienced in recent time, the economic system of Nigeria is in precarious situation and calls for diversification. Focus should be on manufacturing SMEs as they have established themselves as the backbone of industrialized nations. Manufacturing Sector in Nigeria is not making significant contribution to GDP and needs to be giving high level priority. The adoption of Advanced Manufacturing Technology by manufacturing SMEs can aid in enhancing performance as well as fast-track economic development. Awareness need to be created on the importance of AMT in manufacturing so there can be a paradigm shift from conventional manufacturing Technology to bring about global competitiveness of industrial goods vis-à-vis rapid industrial development. It is therefore recommended that there should be active participation of all stakeholders including educators, associations, businesses as well as the three tier of Government.

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