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INVESTIGATION OF FACTORS AFFECTING THE PERFORMANCE OF MANUFACTURING WORKERS IN INDUSTRIES IN SOUTH EASTERN STATES OF NIGERIA

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ABSTRACT: *This paper investigated factors affecting the performance of manufacturing workers in industries in southern Eastern Nigeria. Experiments were designed to investigate those identified specific factors anticipated that have effect on operators of machines in manufacturing shops; to generate information and data needed in the analyses. Results obtained from the various statistical analyses performed were studied and interpreted. The correlation coefficients of the chosen factors: motivation, Power/Energy, safety, Maintenance, Training, equipment, and Technology were respectively calculated and obtained as: 0.95, 0.70, 0.72, 0.78, 0.95, 0.95 and 0.86; the coefficient of determination, R^2 obtained to be 0.948 for overall data, and for each studied factors as: 0.90, 0.49, 0.52, 0.61, 0.91, 0.90 and 0.74 respectively; the variance ratio (VR) is 195.5; and F- value and t – values returned by the SPSS program are greater than the each respective statistical table value at a confidence level of 5%, which indicate good acceptance level. Curves were generated to observe the behavioural patterns of the relationship between manufacturing workers factors effect and their performances. Results obtained show that the identified factors affect the performance of manufacturing workers in the manufacturing industries, with little or no effect of co linearity*.

KEYWORDS: Manufacturing, Industry, Factors, manufacturing workers, Performance and Regression analysis

INTRODUCTION

Organizations of whatever kind (industrial, institutional or governmental) are viable only if they provide satisfactions to the consumers/customers. This satisfaction may either be physical or intangible or both, referred as product/services. This is the general condition for the continued existence of an organization [Andrew C.P. et al, 1998]. The establishment of an effective organization is one of the principles of functions of management. A good organizational plan removes confusion, indecision, back-passing, duplicated efforts and neglected duties. The greatest expectation of production manager is how to convert the available inputs to maximized output (Stevenson, 1999).Productivity is an index that measures output (goods and services) relative to the input (labour, materials, energy and other resources) used to produce them. The

Technological factors are the technological elements that are responsible for the effective practice and operation of engineering and other technological Systems such as power, technology, quality machines and equipment, Technical Training, Safety provision, Adequate maintenance, Human Factors engineering, Conducive working Environment, and Fortified Security Gadgets.

According to Gure, Naima Abdullahi, [2010], Power and Energy are indispensible in the modern manufacturing and needed to be available at a very low cost. This is a great major problem Nigeria manufacturing Industries suffer. Low reliability of machines results to high maintenance and repairs which favours not manufacturing in any company or industry. Effective safety provision tends to stabilize users of machines during operation; this usually removes fears and dangers in workers. Manpower training and development constitute a major aspect of the performance of any employees as it affects the way they behave and perform in the organization. The aim of every reputable organization is to develop an active, effective and appropriate workforce so as to achieve its organizational goal and objectives. Effective and functional equipment and tools are necessary for good manufacturing operations by workers in manufacturing Shops. Adequate provision of these equipment and tools will accelerate the performance of workers. Development and improvement of equipment and tools for improved services in manufacturing Shops brings about the technological factor that affects the manufacturing workers in industries.

Investigations were carried out to validate these factors that have influence on workers performance from engineering perspectives. Data were collected from the production activities of the manufacturing workers through Tests and Time Studies, and analyzed with some statistical tools to produce curves and the factorial indices that validate the research results. One of the major problems of manufacturing firms is how to improve workers productivity (performance measures) [Borman, 2004], and the extent of achieving the objectives of any firm (Greguras, 1996).

Aim and Objectives

The **aim** of this study is to identify factors that affects the performance of manufacturing workers in industries and examine how factors such as: power / energy, maintenance, training, safety, equipment and technology affect the performance of manufacturing workers in industry; whereas the **Objectives** of the study are: to find out the level of significant influence these factors have on the performance of manufacturing worker in his place of work; to use statistical tools and traditional techniques to analyze data collected from the Test and Time studies on those specific factors such as: Motivation, Power/Energy, maintenance, Safety, Training, Equipment and Technology respectively; to develop the situation models that predict performance of manufacturing workers as a function of those investigating factors (independent variables); and to obtain quantitative results (factorial indices) that can be applied in controlling engineering management problems, decision making, and other organizational policies formulation; and providing information to use in the improvement of the work force (workers).

Research Hypotheses

-Performance of manufacturing workers in industries is not affected by:Power /Energy, Safety, maintenance, Training, Equipment and Technology.
-The observed relationship between the dependent and independent variables occurs by chance.
-The Coefficients of the independent variables are not good enough to predict the model.
-The quantitative Times Study data on the various factors does not correspond or fit adequately to the performance measurements of the manufacturing workers.

MATERIALS AND METHODS OF EVALUATION

This section will be reported under the following highlights:

Experimental Apparatus: A total of five (5) manufacturing industries (of one product type) were taken for the study, and different cadres of manufacturing staff (**Subjects)** in the categories of skilled workers, therefore, the sample was made up of Four (4) manufacturing workers each selected from the five selected Companies giving a sum of twenty (20) manufacturing workers used in the study. Stratified random sampling (SRS) was used in selecting the sample size. A 49-item of self made instrument titled "Factorial Indices affecting the performance of manufacturing workers in Industries in south Eastern States of Nigeria" was used for the Tests Study data collection. The items were designed and constructed based on literature reviewed on factors affecting the performance of manufacturing workers in industries in south Eastern States of Nigeria. The Test study specimen was measured on a 5- point of Spits' Liker scale of: Strongly Agree, Agree, Undecided, Disagree, Strongly Disagree which their numerical strength value is 5, 4, 3, 2 and 1 respectively.

A total of Nineteen (19) prepared Test Study were monitored and collected by the researcher. Information supplied as answers to the Test Study were tabulated as shown in tables of appendix I and served as data used in statistical analysis. Further investigations have to be carried out to validate these factors that have influence on workers performance from engineering perspectives based on the data collected from the Times Study on manufacturing operators' production activities of the various manufacturing companies (see appendix II).

Experimental Procedure: Industrial Data Generation

To generate the standard industrial data that sufficiently enough or reliable for use in studying the factorial indices affecting the performance of manufacturing workers in industries, the following guide lines were used for a good study:

- For a named chosen industry, certain numbers of manufacturing workers were selected as the specimens for the Times study which is fixed to be **FOUR** (4) for all the Industries.
- These chosen manufacturing workers are specifically monitored in their daily operations for **FIVE** days of operation. Records were taken based on their daily productivities. From the company's (work measurement) daily production maximum for each machine, the performance of each operator then calculated.
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- Furthermore, each of these **FOUR** chosen Operators were given Tests Study Specimen tagged A_1, A_2, A_3, A_4, for company A; B1, B_2, B_3, B4, for Company B; and so on.

- The responses from the Test studies supplied by the respondents (Operators) on the **SIX** selected factors (rated according to Spit's Liker Scale), were summed up and recorded correspondingly on each of the factors and Operators.
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The average values of the calculated performances of Operators in the five days monitor were tabulated correspondingly with the Subjects' Tests studies which are summed up in the individual operators and factors data and used for statistical Analysis to obtain results. Computer program - EXCEL tools are used for analyzing the various statistical quantities and to test the hypothesis at 0.05 level of confidence (5%).

Tests and Times Studies: Applications of these in this research are important because they provide information about what people do, have, think, know, feel or want; and the information feedback is quantified using the Spit's Liker scale analysis and displayed as shown in tables: 03, 05, 07, 09, and011 (See appendix I) and performance was calculated from the data generated out of the Times Studies, using equation (1) below.

Performance Analysis: Performance is an achievement or output rate over a certain work or activity of a person in absence of delay factors. Operator performance is expressed as the ratio between total standard times for all measured and estimated work done and the time actually spent on that work. The total standard times produced by an operator are a direct function of the number of parts, pieces, amount of weight, volume, etc, produced and the standard times to produce them. Therefore, the total standard times for all measured and estimated work done equal the number of units of work produced, Beeley H (1974), from which:

$$\text{Operator Performance} = \frac{\text{Total standard minutes allotted X 100}}{\text{No of minutes to produce them}}$$

$$\text{Operator Performance} = \frac{\text{Total weight produced x 100}}{\text{Total standard weight to consume}} \quad (1)$$

Determination of Correlation: The EXCEL Linest program Tool was used to determine correlation. This returns the correlation coefficient of the array1 and array2 cell ranges of both the independent and dependent variables. The Pearson product moment correlation coefficient is given by Ojih, (1996, 130) and Nwabuoke (1986, 319) as:

$$\text{CORREL}(X,Y) = \sum(X-\dot{X})(Y-\dot{Y}) / \sqrt{\{\sum(X-\dot{X})^2 \sum(Y-\dot{Y})^2\}} \quad (2)$$

Where $\dot{X}$ and $\dot{Y}$ are the sample means average (array1) and average (array2) respectively.

Test of significance

$$T = R(n-2)^{1/2} / (1-R^2) \quad [\text{Alan O. Sykes, nd.}] \quad (3)$$

Coefficient of Determination, R^2

– determines the extent to which the independent variable X is able to predict the dependent variable Y.

$$R^2 = SSR / SST = b^{2-} \sum(X, -\dot{X}) / \sum(Y - \bar{Y})^2 \quad (4)$$

R^2 = measures good, the effect of X in accounting for the variation in Y. SST divided by n-1 gives the variance of y.

When analyzing the data from a completely randomized experiment like this, two sources of variability can be identified, i.e. variability among treatments and variability within treatments; and the total sum of squares (SST) are partitioned into two sum-of-squares components: SSTR, associated with the variability among treatments– treatment sum of squares and SSE, variability within treatments – error sum of squares. For convenience, SST = SSTR + SSE

$SST = \sum_{j=1}^{k} \sum_{i=1}^{nj} y_{ij} - (\sum_{j=1}^{k} \sum_{i=1}^{nj} y_{ij})^2 / n$, and $n = \sum_{j=1}^{k} n_j$.

$(\sum_{j=1}^{k} \sum_{i=1}^{nj} y_{ij})^2 / n$ = (grand total)^2 / Total no. of observations

$SSTR = \sum_{j=1}^{k} = T_j^2 / n_i - (\sum_{j=1}^{k} \sum_{i=1}^{nj} y_{ij})^2 / n$ and SSE = SST – SSTR (5)

Critical Value: statistical value of a predetermined number, such that all possible values of the text statistics constitute rejection or acceptance region of the critical value.

Evaluation of the models employed for Analysis

Models are employed, which are used in evaluating parameters that quantify results. The parameters to be measured are: coefficient of correlation R, coefficient of determination, R^2;

T- Coefficient, F-values and other Regression coefficients as: significance level, B value, std. error, tolerance and variance of Inflation.

RESULTS AND DISCUSSIONS

Results:

The results are obtained through equations 1 to 5, and illustrated as shown in tables 1-4, 26, 27, and 28; Where X_1, X_2, X_3, X_4, X_5, and X_6 are the various response values or feelings on workers in those factors expressed numerically from Spit's Likert scale or by measurements; the equation (5) is used to predict performance of manufacturing workers when X's values are known.

Workers	Motiva	power	Safety	Maint	training	equipt	Technol	Perform
A_{11}	25	21	20	22	26	22	24	85
A_{12}	24	28	27	26	27	29	28	90
A_{13}	25	24	26	24	25	25	24	87
A_{14}	16	13	14	12	14	15	12	70
B_{11}	19	18	20	19	23	18	10	76
B_{12}	27	26	25	25	24	26	25	89
B_{13}	24	22	20	24	21	22	20	85
B_{14}	25	27	26	27	26	27	27	90
C_{11}	26	25	25	25	24	25	24	87
C_{12}	17	12	14	14	10	12	17	70
C_{13}	20	20	20	17	17	17	15	76

C_{14}	26	27	26	24	24	25	26	89
D_{11}	15	15	20	14	16	14	12	70
D_{12}	18	20	19	18	18	15	16	76
D_{13}	26	26	26	25	26	25	26	89
D_{14}	24	25	23	21	25	20	22	85
E_{11}	28	26	28	26	27	26	26	90
E_{12}	26	24	24	22	25	25	27	87
E_{13}	26	26	28	25	28	27	30	90
A_{21}	17	23	16	20	16	18	17	67
A_{22}	25	30	23	26	24	27	24	85
A_{23}	27	31	24	27	25	29	26	88
A_{24}	19	26	19	23	20	22	20	75
A_{25}	23	28	20	24	22	24	24	79
A_{26}	27	32	25	28	25	29	25	89
A_{27}	15	22	14	18	14	16	13	63
A_{28}	17	24	16	20	17	19	17	68
A_{29}	21	27	20	23	21	23	21	77
B_{21}	26	31	24	27	25	29	26	88
B_{22}	15	21	15	17	13	15	14	60
B_{23}	12	15	12	15	11	13	13	56
B_{24}	16	22	15	19	15	17	16	65
B_{25}	20	26	19	23	20	23	21	76
B_{26}	19	28	20	24	21	24	22	78
B_{27}	23	26	20	23	21	23	23	77
B_{28}	15	22	15	19	15	17	16	64
C_{21}	16	25	17	21	18	20	18	70
C_{22}	13	21	13	17	13	15	14	60
C_{23}	12	12	9	9	9	7	7	45
C_{24}	14	17	12	15	11	13	12	56
C_{25}	23	28	20	24	22	24	22	79
C_{26}	25	28	21	24	22	25	23	80
C_{27}	21	30	23	26	24	27	24	84
C_{28}	14	15	12	15	10	12	11	55
D_{21}	18	25	18	22	19	21	22	72
D_{22}	20	26	20	23	21	23	21	77
D_{23}	16	23	16	19	16	18	16	66
D_{24}	15	19	13	15	11	13	12	56
D_{25}	27	31	22	27	25	29	28	88
D_{26}	10	16	7	12	9	9	6	48
D_{27}	14	19	12	15	10	12	9	55
D_{28}	23	28	18	24	21	24	22	78

A_{31}	14	13	14	13	13	10	14	54
A_{32}	17	11	13	13	16	15	16	60
A_{33}	12	14	15	15	12	10	12	48
A_{34}	10	16	17	18	10	10	15	42
A_{35}	12	18	17	20	8	6	12	34
A_{36}	23	8	6	8	22	22	25	81
A_{37}	23	8	8	8	21	21	24	80
A_{38}	20	10	10	10	20	16	20	72
B_{31}	18	11	12	10	16	14	18	64
B_{32}	22	10	11	10	18	18	21	72
B_{33}	22	8	10	9	18	18	22	73
B_{34}	15	13	13	14	14	11	14	55
B_{35}	10	16	17	18	10	8	18	40
B_{36}	18	12	13	12	16	13	16	60
B_{37}	12	16	16	17	10	9	10	43
B_{38}	16	12	12	11	17	14	18	64
C_{31}	23	9	8	8	21	20	23	79
C_{32}	14	12	14	12	15	12	15	58
C_{33}	30	6	9	7	26	24	30	90
C_{34}	19	10	11	10	18	17	20	70
C_{35}	10	17	19	20	8	9	12	32
C_{36}	14	12	16	17	11	12	10	44
C_{37}	18	10	11	12	17	14	18	65
C_{38}	14	14	16	15	12	9	12	47
D_{31}	18	11	12	14	15	14	16	61
D_{32}	16	13	14	14	14	10	14	53
D_{33}	21	9	10	8	20	20	21	76
D_{34}	20	9	10	9	21	18	20	75
D_{35}	25	12	6	6	25	22	27	84
D_{36}	25	10	9	11	20	22	23	77
SUM	1586	1572	1370	1463	1496	1513	1552	5758
AVER	19.34	19.17	16.7	17.84	18.24	18.45	18.93	70.22

Field work data, 2011

Table 1 above presents the combinations of the data collected from the three Industries, which emerged from the thirteen Companies visited in the course of the study. The performance of the company workers was determined and shown as in appendix 7.

4.1.8 SPSS Regression Analysis of Data from All the Chosen Industries

Table 2 : **Model Summary**[b]

Model	R	R Square	Adj'd R Sq.	Std. Error Estimate
1	.974[a]	.948	.944	3.57356

a. Predictors: (Constant), VAR00016, VAR00013, VAR00010, VAR00012, VAR00014, VAR00011, VAR00015

b. Dependent Variable: VAR00017

Table 3 **ANOVA**[b]

Model		Sum of Sq.	df	Mean Sq	F	Sig.
1	Regression	17385.046	7	2483.578	194.481	.000[a]
	Residual	945.003	74	12.770		
	Total	18330.049	81			

a. Predictors: (Constant), VAR00016, VAR00013, VAR00010, VAR00012, VAR00014, VAR00011, VAR00015

b. Dependent Variable: VAR00017

Table 4 : **Coefficients** [a]

Model		Unstand'd Coeffs		Stand'd Coeffs	t	Sig.	Co linearity Stats	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	26.065	2.087		12.487	.000		
	VAR0001	.877	.263	.302	3.331	.001	.085	11.773
	VAR0002	.480	.225	.232	2.130	.037	.059	16.982
	VAR0003	.614	.233	.231	2.637	.010	.091	10.998
	VAR0004	-1.356	.344	-.550	-3.947	.000	.036	27.857
	VAR0005	.789	.287	.291	2.748	.008	.062	16.096
	VAR0006	1.421	.300	.590	4.736	.000	.045	22.256
	VAR0007	-.459	.185	-.176	-2.474	.016	.138	7.273

a. Dependent Variable: VAR0008

SPSS Regression model of Overall Data Generated

$$P(X_i) = 26.065 + 0.877X_1 + 0.48X_2 + 0.614X_3 - 1.36X_4 + 0.789X_5 + 1.421X_6 - 0.495X_7 \quad (6)$$

SPSS Regression Analysis and Curve Estimation of the Overall Data

Table 5 **Model Summary**

R	R Sq.	Adjusted R Sq.	Std. Error Estimate
.947	.897	.894	4.891

The independent variable is VAR00001.

Table 6 **ANOVA**

	Sum of Sq	Df	Mean Sq	F	Sig.
Regression	16440.043	2	8220.021	343.587	.000
Residual	1890.006	79	23.924		
Total	18330.049	81			

The independent variable is VAR00001.

The percentage contributions of the factors effect on performance are calculated such that motivation = 14%, power = 8%, safety = 10%, maintenance =23% (-), training = 13%, equipment = 24% and technology = 8% (-). The sign (-) indicates that the effect is directed negatively on the performance.

Table 7 **Coefficients**

	Unstand'd Coeffs		Stand'd Coeffs		
	B	Std. Error	Beta	T	Sig.
VAR00001	6.242	.837		7.460	.000
VAR00001 ** 2	-.091	.021	2.147	-4.246	.000
(Constant)	-14.032	7.756		-1.809	.074

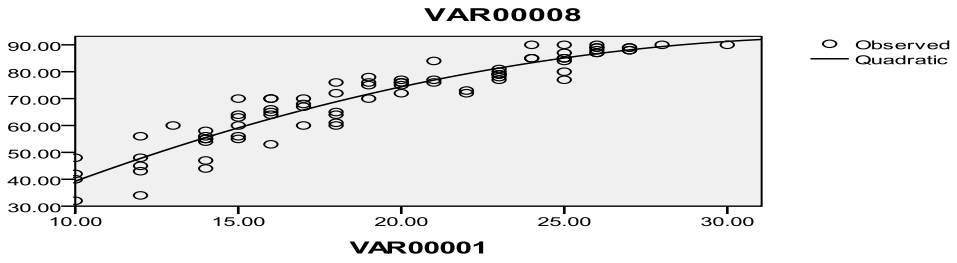

Figure 1: Graph of Performance (VAR00017) and Motivation (VAR00010)

Table 8 **Model Summary**

R	R Square	Adj'd R Square	Std. Error Estimate
.698	.488	.475	10.901

The independent variable is VAR00011.

Table 9 **ANOVA**

	Sum of Sq.	df	Mean Sq.	F	Sig.
Regression	8942.962	2	4471.481	37.631	.000
Residual	9387.087	79	118.824		
Total	18330.049	81			

The independent variable is VAR00011.

Table 10 **Coefficients**

	Unstand'd Coeffs.		Stand'd Coeffs		
	B	Std. Error	Beta	t	Sig.
VAR00011	-5.987	1.099	-2.890	-5.447	.000
VAR00011 ** 2	.182	.028	3.400	6.409	.000
(Constant)	108.708	9.555		11.377	.000

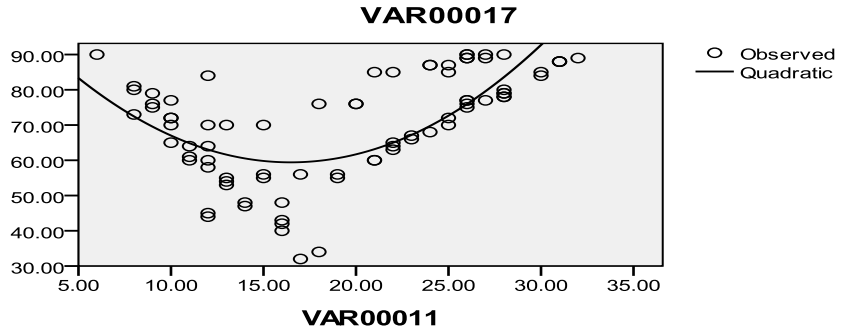

Figure 2: Graph of Performance (VAR00017) and Power (VAR00011)

Table 11 **Model Summary**

R	R Sq.	Adj'd R Sq	Std. Error Estimate
.721	.520	.501	10.622

The independent variable is VAR00012.

Table 12 **ANOVA**

	Sum of Sq	Df	Mean Sq	F	Sig.
Regression	9530.012	3	3176.671	28.157	.000
Residual	8800.037	78	112.821		
Total	18330.049	81			

Table 12 **ANOVA**

	Sum of Sq	Df	Mean Sq	F	Sig.
Regression	9530.012	3	3176.671	28.157	.000
Residual	8800.037	78	112.821		
Total	18330.049	81			

The independent variable is VAR00012.

Table 13 **Coefficients**

	Unstand'd Coeffs.		Stand'd Coeffs.		
	B	Std. Error	Beta	T	Sig.
VAR00012	-19.665	4.852	-7.399	-4.053	.000
VAR00012 ** 2	1.083	.301	14.219	3.594	.001
VAR00012 ** 3	-.017	.006	-6.428	-2.908	.005
(Constant)	169.306	24.392		6.941	.000

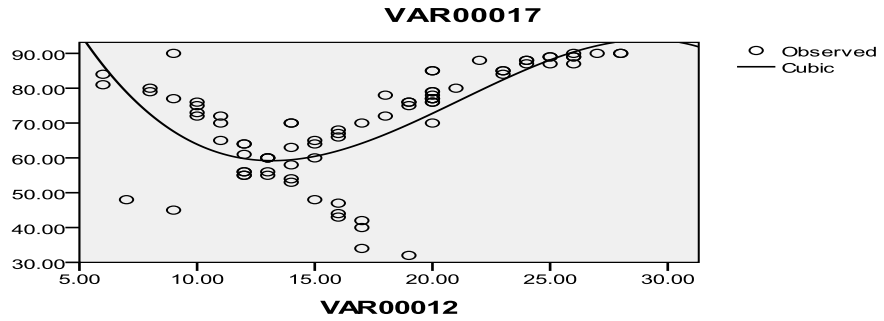

Figure 3: Graph of Performance (VAR00017) and Safety (VAR00012)

Table 14 **Model Summary**

R	R Square	Adj'd R Sq.	Std. Error Estimate
.782	.611	.597	9.556

The independent variable is VAR00013.

Table 15 **ANOVA**

	Sum of Sq	Df	Mean Sq	F	Sig.
Regression	11207.850	3	3735.950	40.915	.000
Residual	7122.198	78	91.310		
Total	18330.049	81			

The independent variable is VAR00013.

Table 16 **Coefficients**

	Unstand'd Coeffs.		Stand'd Coeffs.		
	B	Std. Error	Beta	t	Sig.
VAR00013	-19.851	4.830	-8.048	-4.110	.000
VAR00013 ** 2	.964	.297	13.799	3.243	.002
VAR00013 ** 3	-.013	.006	-5.379	-2.271	.026
(Constant)	181.282	24.323		7.453	.000

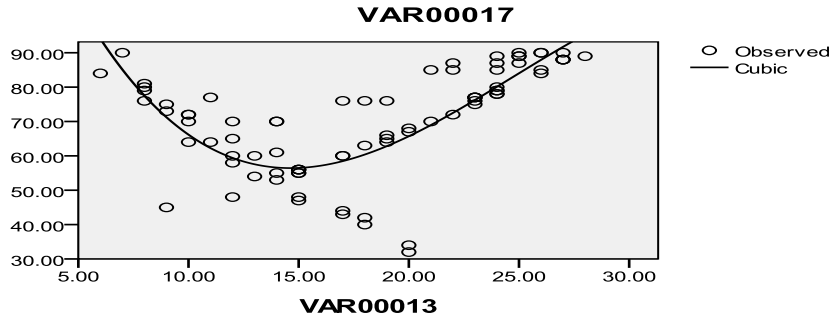

Figure 4: Graph of Performance (VAR00017) and Maintenance (VAR00013)

Table 17 **Model Summary**

R	R Sq.	Adjd R Sq	Std. Error Estimate
.951	.905	.903	4.697

The independent variable is VAR00014.

Table 18 **ANOVA**

	Sum of Sq.	Df	Mean Sq	F	Sig.
Regression	16587.481	2	8293.740	376.000	.000
Residual	1742.568	79	22.058		
Total	18330.049	81			

The independent variable is VAR00014.

Table 19 **Coefficients**

	Unstand'd Coeffs.		Stand'd Coeffs		
	B	Std. Error	Beta	t	Sig.
VAR00014	4.168	.667	1.537	6.253	.000
VAR00014 ** 2	-.045	.018	-.596	-2.423	.018
(Constant)	10.442	5.620		1.858	.067

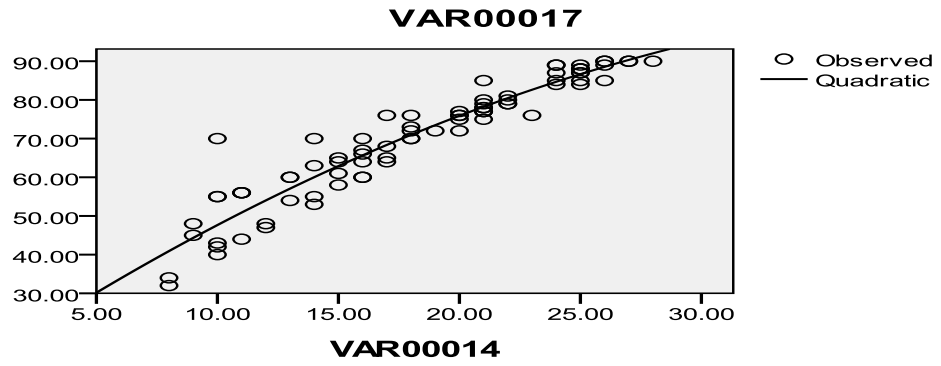

Figure 5: Graph of Performance (VAR00017) and Training (VAR00014)

Table 20 **Model Summary**

R	R Sq	Adjusted R Sq	Std. Error Estimate
.946	.895	.892	4.944

The independent variable is VAR00015.

Table 21 **ANOVA**

	Sum of Sq	Df	Mean Sq	F	Sig.
Regression	16398.962	2	8199.481	335.438	.000
Residual	1931.087	79	24.444		
Total	18330.049	81			

The independent variable is VAR00015.

Table 22 **Coefficients**

	Unstand'd Coeffs		Stand'd Coeffs		
	B	Std. Error	Beta	t	Sig.
VAR00015	4.679	.552	1.941	8.470	.000
VAR00015 ** 2	-.067	.015	-1.023	-4.462	.000
(Constant)	9.095	4.735		1.921	.058

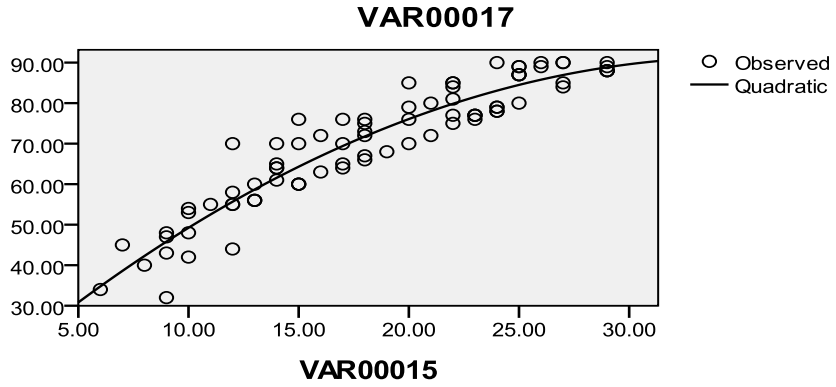

Figure 6: Graph of Performance (VAR00017) and Equipment (VAR00015)

Table 23 **Model Summary**

R	R Sq	Adj'd R Sq	Std. Error Estimate
.861	.741	.738	7.705

The independent variable is VAR00016.

Table 24 **ANOVA**

	Sum of Sq.	Df	Mean Sq.	F	Sig.
Regression	13580.357	1	13580.357	228.737	.000
Residual	4749.692	80	59.371		
Total	18330.049	81			

The independent variable is VAR00016.

Table 25 **Coefficients**

	Unstand'd Coeffs.		Stand'd Coeffs		
	B	Std. Error	Beta	T	Sig.
VAR00016	2.241	.148	.861	15.124	.000
(Constant)	27.800	2.931		9.485	.000

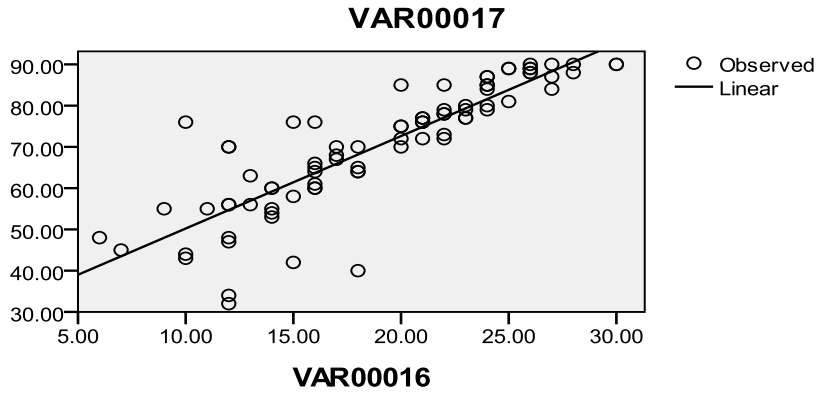

Figure 7: Graph of Performance (VAR00017) and Technology (VAR00016)

Table 26 : Model Summaries[h] for all the elementary factors compared

Model	R	R Square	Adj'd R Sq.	Std. Error Estimate	Change Statistics				
					R Sq. Change	F Change	df1	df2	Sig. F Change
1	.948[a]	.898	.897	4.83740	.898	703.321	1	80	.000
2	.958[b]	.918	.916	4.36630	.020	19.194	1	79	.000
3	.965[c]	.930	.928	4.04236	.013	14.169	1	78	.000
4	.967[d]	.935	.932	3.92109	.005	5.899	1	77	.017
5	.969[e]	.939	.935	3.82305	.004	5.000	1	76	.028
6	.972[f]	.945	.941	3.65684	.006	8.066	1	75	.006
7	.974[g]	.948	.944	3.57356	.003	4.537	1	74	.037

a. Predictors: (Constant), VAR00005

b. Predictors: (Constant), VAR00005, VAR00006

c. Predictors: (Constant), VAR00005, VAR00006, VAR00004

d. Predictors: (Constant), VAR00005, VAR00006, VAR00004, VAR00003

e. Predictors: (Constant), VAR00005, VAR00006, VAR00004, VAR00003, VAR00007

f. Predictors: (Constant), VAR00005, VAR00006, VAR00004, VAR00003, VAR00007, VAR00001

g. Predictors: (Constant), VAR00005, VAR00006, VAR00004, VAR00003, VAR00007, VAR00001, VAR00002

h. Dependent Variable: VAR00008

Table27 ANOVA[h]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	16458.014	1	16458.014	703.321	.000[a]
	Residual	1872.035	80	23.400		
	Total	18330.049	81			
2	Regression	16823.945	2	8411.972	441.235	.000[b]
	Residual	1506.104	79	19.065		
	Total	18330.049	81			
3	Regression	17055.477	3	5685.159	347.915	.000[c]
	Residual	1274.571	78	16.341		
	Total	18330.049	81			
4	Regression	17146.177	4	4286.544	278.800	.000[d]
	Residual	1183.872	77	15.375		
	Total	18330.049	81			
5	Regression	17219.256	5	3443.851	235.627	.000[e]
	Residual	1110.793	76	14.616		
	Total	18330.049	81			
6	Regression	17327.112	6	2887.852	215.955	.000[f]
	Residual	1002.937	75	13.372		
	Total	18330.049	81			
7	Regression	17385.046	7	2483.578	194.481	.000[g]
	Residual	945.003	74	12.770		
	Total	18330.049	81			

a. Predictors: (Constant), VAR00005

b. Predictors: (Constant), VAR00005, VAR00006

c. Predictors: (Constant), VAR00005, VAR00006, VAR00004

d. Predictors: (Constant), VAR00005, VAR00006, VAR00004, VAR00003

e. Predictors: (Constant), VAR00005, VAR00006, VAR00004, VAR00003, VAR00007

f. Predictors: (Constant), VAR00005, VAR00006, VAR00004, VAR00003, VAR00007, VAR00001

g. Predictors: (Constant), VAR00005, VAR00006, VAR00004, VAR00003, VAR00007, VAR00001, VAR00002

h. Dependent Variable: VAR00008

*In all the existence and combinations of the factors they are significant i.e. affect performance.

Table 28 Coefficients [a] of all the various existence and combinations of the factors.

Model		Unstandd Coeffs		Stand'd Coeffs.	T	Sig.	95% Conf Interv for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta	T	Sig.	Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	23.345	1.846		12.643	.000	19.671	27.020					
	VAR00005	2.569	.097	.948	26.520	.000	2.377	2.762	.948	.948	.948	1.000	1.000
2	(Constant)	23.882	1.671		14.291	.000	20.556	27.208					
	VAR00005	1.618	.234	.597	6.915	.000	1.153	2.084	.948	.614	.223	.140	7.162
	VAR00006	.911	.208	.378	4.381	.000	.497	1.325	.932	.442	.141	.140	7.162
3	(Constant)	27.393	1.807		15.163	.000	23.797	30.990					
	VAR00005	1.312	.231	.484	5.666	.000	.851	1.772	.948	.540	.169	.122	8.175
	VAR00006	1.384	.230	.574	6.020	.000	.926	1.841	.932	.563	.180	.098	10.207
	VAR00004	-.372	.099	-.151	-3.764	.000	-.569	-.175	.417	-.392	-.112	.556	1.800
4	(Constant)	28.471	1.808		15.750	.000	24.871	32.071					

	VAR00005	.889	.284	.328	3.132	.002	.324	1.455	.948	.336	.091	.076	13.074
	VAR00006	1.733	.265	.719	6.531	.000	1.205	2.262	.932	.597	.189	.069	14.458
	VAR00004	-.923	.246	-.374	-3.747	.000	-1.414	-.433	.417	-.393	-.109	.084	11.902
	VAR00003	.599	.247	.226	2.429	.017	.108	1.091	.490	.267	.070	.097	10.278
5	(Constant)	29.838	1.866		15.995	.000	26.122	33.553					
	VAR00005	1.080	.290	.398	3.728	.000	.503	1.657	.948	.393	.105	.070	14.313
	VAR00006	1.946	.276	.807	7.059	.000	1.397	2.494	.932	.629	.199	.061	16.402
	VAR00004	-1.003	.243	-.407	-4.130	.000	-1.487	-.520	.417	-.428	-.117	.082	12.166
	VAR00003	.628	.241	.236	2.606	.011	.148	1.108	.490	.286	.074	.097	10.307
	VAR00007	-.413	.185	-.158	-2.236	.028	-.780	-.045	.861	-.248	-.063	.159	6.298
6	(Constant)	26.577	2.122		12.525	.000	22.350	30.804					
	VAR00005	.803	.294	.296	2.733	.008	.218	1.388	.948	.301	.074	.062	16.087
	VAR00006	1.690	.279	.701	6.069	.000	1.136	2.245	.932	.574	.164	.055	18.307
	VAR00004	-.823	.241	-.334	-3.418	.001	-1.303	-.343	.417	-.367	-.092	.076	13.072

	VAR00003	.519	.234	.195	2.219	.029	.053	.984	.490	.248	.060	.094	10.594
	VAR00007	-.557	.184	-.214	-3.033	.003	-.923	-.191	.861	-.331	-.082	.147	6.820
	VAR00001	.743	.262	.256	2.840	.006	.222	1.264	.935	.312	.077	.090	11.099
7	(Constant)	26.065	2.087		12.487	.000	21.906	30.225					
	VAR00005	.789	.287	.291	2.748	.008	.217	1.361	.948	.304	.073	.062	16.096
	VAR00006	1.421	.300	.590	4.736	.000	.823	2.019	.932	.482	.125	.045	22.256
	VAR00004	-1.356	.344	-.550	-3.947	.000	-2.041	-.672	.417	-.417	-.104	.036	27.857
	VAR00003	.614	.233	.231	2.637	.010	.150	1.077	.490	.293	.070	.091	10.998
	VAR00007	-.459	.185	-.176	-2.474	.016	-.828	-.089	.861	-.276	-.065	.138	7.273
	VAR00001	.877	.263	.302	3.331	.001	.353	1.402	.935	.361	.088	.085	11.773
	VAR00002	.480	.225	.232	2.130	.037	.031	.929	.471	.240	.056	.059	16.982

a. Dependent Variable: VAR00008.

*In model 7, where all the factors appear, Var 006 and Var 004 show co linearity problem, in which one of the two factors can be redundant, but all the factors are significant in the analyses.

RESULT OF HYPOTHESES TESTING

1 H_{o1}: Performance of manufacturing workers in industries is not affected by:Power and Energy, Safety, Maintenance, Training, Equipment and Technology. From the Table 3 of the regression analysis at the degree of freedom obtained, the value of F-statistic returned by the LINEST is greater than the $F_{critical}$ value from the statistical table at 5% confidence level. Since F_{satist} = 3.84 and F_{critic} value returned by SPSS is 194.48, therefore the performance of manufacturing worker is affected by these treatment variables: Power and Energy, Safety, Maintenance, Training, Equipment and Technology.

2 Testing for hypothesis two, which says that whether the relationship between performance and the predictors occurs by chance or not; Since the observed F_{critic} value returned by LINEST output 195 is greater the F_{stat} value from the statistic table (3.84), the relationship does not occur by chance and the probability of not occurring by is 7.42579E-08

3 Looking at the Regression equation of (6) and table 4, it is observed that the ratio of the slope (m) coefficients on each treatment to the corresponding standard error, (Se_i) of its coefficient of the form: $t = m_1 / Se_1$ or $m_2 / Se_2 \ldots m_n / Se_n > t_{stat}$ statistic table value of 1.895 at 5% confidence level and at the specified degrees of freedom. The table below shows the absolute values of the seven t-observed values is in agreement to the Test conditions.

If the absolute value of **t** of all the treatments is sufficiently high, greater than the value of t_{stat} obtained from the statistic table, it is then inferred that the slope coefficients are valid or useful in estimating the assessed value of the performance of the manufacturing workers in industries, as returned by the SPSS Software program. The values of co-efficient of correlation obtained in the calculations on the various treatments show that all maintain positive correlation and there is a degree of correlation between the factors and the Performance of manufacturing workers as shown.

These values of the co-efficient of correlation of the various considered factors that showed good correlation co-efficient with the dependent variable, performance which further points that any improvements in the factors will correspondingly improve or increase the performances of manufacturing workers. It is also showed that the combine studies of the Tests and Time studies in the course of carrying out the Experiments were strictly conducted, and further indicated that the application of the various tools used were properly designed and controlled. Though, it is very difficult to control the feelings and behavior of manufacturing workers in natural state, but effective designs and implementation of the research tools have given rise to this high yielding of results. It is also suggesting that by effective design of Test Study and control, the performance of manufacturing workers in Industry can be highly improved.

Looking into the output of the SPSS returned results, the Regression equation of the combined data collected showed that the performance of manufacturing workers can be rightly predicted by these factors' co-efficient which will further be confirmed by the coefficient of determination, R^2 = 0.993.

A review of the hypothesis test results will also indicate that the research is uniquely conducted and is reliable. The Treatments such as Motivation, Power/Energy, Safety, Maintenance, Training, Equipment and Technology are observed to have been affecting the performance of manufacturing workers. The positive values of correlation coefficient depict also that the treatments affect the performance positively and that for any improvement apply to the Treatments, this will invariably improve the performance positively.

DISCUSSION OF RESULTS

There are figures and tables that determines co-efficient of correlation for the various considered factors that showed good correlation co-efficient with the dependent variable- performance, which further points that any improvements in the factors will correspondingly improve or increase the performances of manufacturing workers. It also showed that the combine studies of the Tests and Time studies in the course of carrying out the Experiments were strictly conducted, and further indicated that the application of the various tools used were properly designed and controlled. Though, it is very difficult to control the feeling of manufacturing workers in natural state, but effective designs and implementation of the tools have given rise to these high yielding results. It is also suggesting that by design of the elements' processes and control, the performance of manufacturing workers in Industry can be highly improved.

Looking into the output of the SPSS returned results, Table 4; the Regression equation (6) of the combined data collected shows that the performance of manufacturing workers can be rightly predicted by these factors' co-efficient which further be confirmed by the coefficient of determination, $R^2 = 0.948$. The polynomial graphs of the scattered plot showed equally also high values of R^2 (see figures 1-6).

A review of the hypothesis test results show that the research is uniquely conducted and is reliable. The Treatments such as Motivation, Power/Energy, Safety, Maintenance, Training, Equipment and Technology are greatly observed to be affecting the performance of manufacturing workers. The positive values of correlation coefficient depict also that the treatments affect the performance positively and if there is any improvement apply to the Treatments, this will invariably improve the performance. It is seen that the percentage contributions of the factors effect on performance are calculated such that motivation = 14%, power = 8%, safety = 10%, maintenance =23% (-), training = 13%, equipment = 24% and technology = 8% (-).

Regression on stepwise processes via: model summary, ANOVA, coefficients and excluded of tables 26, 27 and 28 variables, present results that are significant which is comparable to the results obtained from ordinary regression analysis as earlier deduced, see tables 5 to 25.

There is no problem of co linearity as the Variance Inflation Factor (VIF) values i.e. the reciprocal of tolerance values are below the number 20 in table 28, which implied that all the elemental factor (treatments) are important in predicting performance of manufacturing workers in Industries. In the last row of figure 28, it is observed that maintenance and equipment deviate slightly and so show little co linearity, which implies that if there be new equipment all over;

there will be no need of maintenance in the combined factors considered in predicting performance of manufacturing workers.

CONTRIBUTION TO KNOWLEDGE

- The research identifies and proves some specific factors responsible for poor performances of manufacturing workers in industries.
- It offers the possible solutions for the improvement in the performance of manufacturing workers in manufacturing industries.
- The result obtained from the research would be applied in controlling engineering management problems, decision making, and other government policies formulation.
- The result of the research serves as one of the sources of information to be used in improving the work force (workers) conditions of service.
- It will be used to quantify solutions to certain problems that usually occur in establishments especially in manufacturing industries.

RECOMMENDATION

Several other techniques such Gaussian elimination and Analysis of Variance have to be employed to validate the results obtained.

- This research has to be carried out indifferent regions in Nigeria and other parts of the world.

- Industries should create atmosphere of cooperation with institutions researchers for effective researches.

- Establishments should endeavour to provide adequate facilities for effective performance.

- Government should contribute for adequate provision of Electricity in the South Eastern States of Nigeria to encourage continuous manufacturing in manufacturing firms.

CONCLUSSION

From the analyses of data and the results, it is categorically observed and concluded that Motivation, Power/Energy, Safety, Maintenance, Training, Equipment and Technology are among the factors which affect the performance of manufacturing workers in manufacturing firms especially in the South Eastern Nigeria. It is uniquely observed from the correlation co efficient that these factors are positive in affecting the performance. Furthermore, it can be observed that the more other factors are considered to be improved upon, the higher the performances (see the stepwise or exclusive regression). Lightening (brightness), Working Compartment Temperature, Provisions of basic Utilities, Incentives, good incentives treatments to Workers, and Working Hours are some of the factors that will further enhance the performance of manufacturing workers if well integrated into a manufacturing System**.**

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