European Journal of Business and Innovation Research
Vol.1, No.1, March 2013, pp. 44-71
Published by European Centre for Research, Training and Development, UK (www.ea-journals.org)

INVESTIGATION OF SOME FACTORS AFFECTING MANUFACTURING WORKERS PERFORMANCE IN INDUSTRIES IN ANAMBRA STATE OF NIGERIA

Nwosu M. C., Ikwu G. O. R. and Uzorh A.C

Department of Industrial and Production Engineering, Unizik, Awka, Nigeria

Abstract: *The poor Company's output is directly related to the poor performance of the production workers, which is a function of how effective are those factors influencing production is maintained in the manufacturing workers. Therefore a survey of the factors affecting manufacturing workers in industries in Anambra State was carried out to ascertain whether there is any effect of the factors on the productivity of workers, and by what degree is the effect, and what improvement to be made in the problems arising in manufacturing due to the factors. Experiments were designed to investigate those identified specific factors that have effect on operators of machines in manufacturing shops to generate data needed in the analyses. Results obtained from the various statistical analyses performed were studied and interpreted. The multi linear regression of correlation coefficients, R and coefficient of determination, R^2 of the chosen factors: Power/Energy, safety, Maintenance, Training, and Technology were respectively calculated to justify the data. Other information were presented in graphs and tables validating the claims over the results, whether any of the factors affecting or not affecting the performance of manufacturing workers in Industries in Anambra State. Results obtained show that some of the identified factors affect the performance of manufacturing workers in the manufacturing industries. Finally, there is no co-linearity among the factors.*

Keywords: Industry**,** Factorial Indices, manufacturing workers, Performance, Regression Coefficients and Co-linearity.

1.0 Introduction

Historically**,** manufacturing was usually carried out by a single skilled artisan with assistants, until the era of industrialization when workers were employed to work, that the guild system protected the rights and privileges of workers. In spite of this development, even to date, and there are still inadequacies in achieving satisfaction to manufacturing workers. This situation is then one of the reasons for low performance of manufacturing workers. More so, there are some factors of production that are found to greatly affect the performance, but few of these factors were selected for studies in this research. In summary, in any of the production unit, production workers or employees problems may either be power, trainings, maintenance, motivations, technology and safety or others which are also the problems of the company's management. The amount of mental energy that a production worker is prepared to expend on a job to achieve a certain level of performance varies with the availability of those factors, incentive and motivation. The reality of the effects and quantitative significance of those factors have not been established with relevance to Anambra State of Nigeria, a case study.

This leads to collection two forms of data- information from the individual workers through oral examination (Test Study) and industrial measurement of work capability (affected by these factors) of individual manufacturing workers (Time Study) in various the establishments or Industries under study in the State. The data generated are organized in tables.

1.1Problem of the Study

The most important dependent variable in industrial and organizational psychology is job performance which is a product of workers performance. One of the major concerns of manufacturing companies is focused on improving worker productivity, which is one of the job performance measures, (Borman, 2004). Greguras (1996) describes job performance as the extent to which an organizational member (production worker) contributes to achieving the objectives of the organization. Employee's motivation is one of the strategies that managers must not overlook to enhance effective job performance among production workers in organizations. Motivation is the management process of influencing behaviour based on the knowledge of what make people tick (Luthans, 1998).

Incessant power outage and high cost of diesel paralyze the ability and effort of production workers while the profit margin that could have been high enough to better the conditions of the production workers are drastically reduced by high cost of diesel and maintenance of generators. In Nigeria, not only in Anambra State, poor electricity supply is perhaps the greatest infrastructure problem confronting the manufacturing sector. The typical Nigeria firm experiences power failure or fluctuations about fourteen times per week, each lasting for about two hours or more without the benefit of prior warning. This imposes a huge cost on the firm arising from idle production workers, spoiled materials, lost output, damaged equipment and restart costs. Training, Safety, Maintenance/Repair, Technology, Equipment are also causing retrogression in overall Company's effectiveness. Other factors, such as Leadership effectiveness, Time management, Process change, Cycle time, Shift duration, environmental Conditions and Anthropological characters are also affect the manufacturing workers performance in the manufacturing industry in Anambra State of Nigeria

I.2 Aims of the Study

The aim of this study is to determine the factorial indices affecting manufacturing workers in industries in Anambra state of Nigeria.

1.3 Objectives of the Study: The objectives of this thesis are

1. To determine joint and relative contributions of the independent variables (Power/energy, training, motivation, technology, maintenance/repairs and safety) to the manufacturing workers performance.
2. To determine any significant relationship that exists between these independent and the dependent variables.

3. To determine quantitative measure or factorial indices of the various independent variables affecting production worker.
4. To develop models that predict enhancement module of manufacturing workers performance in industry.

1.4 Hypotheses

Condition for Acceptance or Rejection of the hypothesis,

at 0.05 significance level:

$$H_1 < \text{Significance level} < H_0$$

Ho: That those factors, Power/Energy, Training, motivation, Maintenance/Repairs, Technology & Safety does not affect the performance of manufacturing workers.

Ho: That these slope coefficients in the model do not predict the model generated correctly.

Ho: That the results obtained occurred by chance.

This study is therefore intended to assist in filling the gap through an in-depth study of some but not all factors that affects manufacturing employees (workers). Anambra State and plastic manufacturing industries were taken as a case study. For this purpose, relevant literature in the field of study and other stakeholders in medium and large scale industries were reviewed. This is done with a view to understanding those strategic factors constraining the effective performance of production worker in manufacturing industries in Anambra State in particularly and in the country in general.

2.0 Literature Review

The most important dependent variable in industrial and organizational psychology is worker (job) performance. According to Borman (2004), one of the major concerns of manufacturing companies is improving workers productivity, which is one of the job performance measures. Gregura, Ployhart and Balzer (1996) described job performance as the extent to which a company worker contributes in achieving the objectives of the organization. Keller (2006) puts it that, when you expect the best output from your employees, they will be given the best treatment. On the other hand, when you give employees low incentives and motivation, you receive low performance in return, which was named by Marizoni and Barsoux (2004) as set-up to fail syndrome.

A lot of factors affect the performance of a production worker positively in Nigerian manufacturing firms, in South Eastern States as case study. These factors include but not limited to (i) Power/Energy infrastructure (ii) Trainings (iii) Motivations (iv) machines reliability, (v) Technology and Technological changes and (vi) Work place safety (vii) Standard Equipment. However, other factors, such as, leadership effectiveness, time management, process change and others, also influence the production worker performance in the medium and large-scale manufacturing industry in Nigeria. These factors have been found individually to have been affecting manufacturing workers performance in industry, and it is very important now to under study if some combination of two or more factors can affect performance as much or less of the individual factors. This phenomenon demands the use of multi-linear regression approach in the analysis. The outputs of the single and multiple factors results can be compared. This is one of the intentions of this noble work.

3.0 Methodology

This research work utilized both primary and secondary methods of data collection. The primary data collection was obtained from three plastic manufacturing firms in Anambra State: Millennium industries Awka, Sunflower plastic industries Awka and Louis carter industries Nnewi. In ensuring high validity of the primary data, personal supervisions of workers performance (time studies) daily were carried out.

The observation technique applied assists immensely in confirming the organizations' facilities, operational procedures, level of motivations provided, safety precautions adopted, technical and managerial competence and more importantly production workers actual daily output in relation to company's maximum daily quantity target. The Secondary data collection was through Test Study (Finding reality from individual workers) and sources which include textbooks, internet exploration, seminar papers, journals, magazines and periodicals. In fact, published literatures from both internal and external sources served as secondary data source.

3.1 Methodologies in Data Analysis [WAYNE W. DANIEL, (1977),]

3.1 Theoretical Data Analyses

In general, one may display the measurements or observations from a completely randomized design consisting of k treatment levels as shown in table 2 below.

The symbols used in table 2 are defined as follows.

y_{ij}= ith measurement from treatment j, where i= 1, 2,……..nj

and j= 1,2,…..k

$$T.j = \sum_{i=1}^{nj} yij = total\ of\ the\ measurments\ in\ the\ jth\ column \quad (1)$$

$$\bar{y}._j = \frac{T.j}{n_j} = \frac{\sum_{i=1}^{nj} y_{ij}}{n_j} = means\ of\ the\ measurments\ in\ the\ jth\ column \quad (2)$$

Table 1: Measurement obtained from a completely randomized experiment

Treatment								
	1	2	3	.	.	.	k	
	Y_{11}	y_{12}	y_{13}	.	.	.	y_{1k}	
	y_{21}	y_{22}	y_{23}	.	.	.	y_{2k}	
	.	.	.					
	.	.	.					
	.	.	.					
	Y_{i1}	y_{i2}	y_{i3}	.	.	.	y_{ik}	
	.							
	.							
	.							
	$Y_{n1}{}^{1}$	$y_{n2}{}^{2}$	$y_{n3}{}^{3}$	.	.	.	$y_{nk}{}^{k}$	
Total	$T_{\cdot 1}$	$T_{\cdot 2}$	$T_{\cdot 3}$	.	.	.	$T_{\cdot k}$	$T_{..}$
Mean	$\bar{y}_{\cdot 1}$	$\bar{y}_{2}$	$\bar{y}_{\cdot 3}$	.	.	.	$\bar{y}_{\cdot k}$	$\bar{y}_{..}$
Variance	S_1^2	S_2^2	S_3^2	.	.	.	S_k^2	$S^2{}_{..}$

The variance of the measurement in the jth column is given as

$$S_j^2 = \frac{\sum_{i=1}^{nj}(y_{ij}-\bar{y}_j)^2}{n_j-1} \qquad (3)$$

Total of all measurements $T.. = \sum_{j=1}^{k} T_{\cdot j} = \sum_{j=1}^{k} \sum_{i=1}^{nj} y_{ij}$ (4)

Mean of all measurements, $\bar{y}.. = \frac{T_{..}}{n}$ $when\ n = \sum_{j=1}^{k} n_j$ (5)

Then variance of all measurements

$$S^2 = \frac{\sum_{j=1}^{k}\sum_{i=1}^{nj}(y_{ij}-\bar{y}_{..})^2}{n-1} \qquad (6)$$

The total sum of squares then is partitioned into two sum of squares components, one associated with variability among treatments and one with variability within treatments. The sum of squares (abbreviated SS) ascribable to variability within treatments in generally referred to as the error sum of squares (SSE).

Using the symbols of table 2, we may write the results of the partitioning as follows:

$$\sum_{j=1}^{k}\sum_{i=1}^{nj}(y_{ij} - \bar{y}_{..})^2 = \sum_{j=1}^{k} n_j\ (\bar{y}_{.j} - \bar{y}_{..})^2$$

$$+ \sum_{j=1}^{k}\sum_{i=1}^{nj}(y_{ij} - \quad \bar{y}_{\cdot j})^2 \qquad (7)$$

Total sum of squares = Treatment sum of squares + error sum of sources,

SST = Total sum of squares

SSTR = Treatment sum of squares

SSE = error sum of squares

∴ The partitioned total sum of squares is expressed as

SST = SSTR + SSE

In summary SST = $\sum_{j=1}^{k}\sum_{i=1}^{nj} y_{ij}^2 - C$ (8)

= (sum of all squared observations) – C

Where

$$C = \frac{T_{..}^2}{n} = \frac{\left(\sum_{j=1}^{k}\sum_{i=1}^{nj} y_{ij}\right)^2}{n} = \frac{(grand\ totla)^2}{total\ number\ of\ obervations} \qquad (9)$$

and $n = \sum_{j=1}^{k} nj$

SSTR = $\sum_{j=1}^{k}\frac{T_{.j}^2}{nj} - C$ = (sum of all squared totals divided by the corresponding group size) – C

(10)

Finally, the error sum of squares is obtained by subtraction

SSE = SST – SSTR (11)

Although it is possible to compute SSE directly, the calculations are quite tedious, and consequently it is more practical to obtain this quantity by subtraction.

Also variance ratio (VR) is given as the ratio of the treatment mean square to the error mean square.

Variance Ratio VR = $\frac{MSTR}{MSE}$ (12)

Variance ratio is the test statistic used to determine whether or not to reject H_0; through the valid use of this test statistics rests on a set of well defined assumptions.

Table 2: ANOVA table for one-way analysis of variance

Source of variation	SS	Df	MS	VR
Treatments	SSTR	K - 1	MSTR $=\frac{SSTR}{K-1}$	$\frac{MSTR}{MSE}$
Error	$\frac{SSE}{SST}$	$\frac{n-k}{n-1}$	MSE= $\frac{SSE}{n-K}$	-

3.2 Manufacturing Workers Performance [BEELEY, H; (1977),]

The workers daily performance is calculated using the relation

$$P\,(x_1) = \frac{Q_2}{Q_1}$$

Where Q_1 = fixed or max. Daily machine capacity

Q_2 = Actual daily output and

P (x_1) = worker perform each day

$$\text{Worker performance each day} = \frac{\textit{Actual daily output}}{\textit{fixed or max.Daily machine capacity}} \qquad (13)$$

Meanwhile, machine daily max capacity is given by the relation below.

$$\text{Max capacity per day} = \frac{\text{Daily working hour}}{\text{Cycle time}}$$

$$\therefore \text{Cycle time} = \frac{\text{one hour}}{\text{Max. Capacity per hour}} \qquad (14)$$

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 total standard times for all measured and estimated work done from which

$$Operator\ Performanc = \frac{units\ of\ work\ produced\ x\ cycle\ time}{number\ of\ minutes\ use\ to\ produce\ them}\ x\ \frac{100}{1} \qquad 15a$$

$$Operator\ Performance = \frac{total\ standard\ minutes\ produced}{number\ of\ minutes\ to\ produce\ them}\ x\ \frac{100}{1} \qquad 15b$$

Also

$$Operator\ Performance = \frac{Idle\ time\ used}{actual\ time\ taken}\ x\ \frac{100}{1} \qquad 15c$$

Table 3: Treatments and Performance Values Generated from the Test and Time Studies

Company workers	Power X_1	Training X_2	Motivation X_3	Technology X_4	M/repairs X_5	Safety X_6	Performance P
L_1	13	14	13	13	10	14	54
L_2	11	13	13	16	15	16	60
L_3	14	15	15	12	10	12	48
L_4	16	17	18	10	8	9	42
L_5	18	17	20	8	6	6	34
L_6	8	6	8	22	22	25	81
L_7	8	8	8	21	21	24	80
L_8	10	10	10	20	16	20	72
L_9	11	12	10	16	14	18	64
L_{10}	10	11	10	18	18	21	72
S_{11}	10	10	9	18	18	20	73
S_{12}	13	13	14	14	11	14	55
S_{13}	16	17	18	10	8	9	40
S_{14}	12	13	12	16	13	16	60
S_{15}	16	16	17	10	9	10	43
S_{16}	12	12	11	17	14	18	64
S_{17}	9	8	8	21	20	24	79
S_{18}	12	14	12	15	12	16	58
S_{19}	6	7	5	24	24	25	90

European Journal of Business and Innovation Research
Vol.1, No.1, March 2013, pp. 44-71
Published by European Centre for Research, Training and Development, UK (www.ea-journals.org)

S_{20}	10	11	10	18	17	20	70
M_{21}	20	19	20	8	6	6	32
M_{22}	16	16	17	11	12	10	44
M_{23}	10	11	12	17	14	18	65
M_{24}	14	16	15	12	9	12	47
M_{25}	11	12	14	15	13	16	61
M_{26}	13	14	14	14	10	14	53
M_{27}	9	10	8	20	19	21	76
M_{28}	9	10	9	21	18	22	75
M_{29}	12	6	6	22	22	25	84
M_{30}	10	9	11	20	20	23	77

NB: L = Louis Carter work, S = Sunflower workers, M = Millennium worker

4.0 Data Analyses and Result Discussions

Collation and analysis of data obtained from the three companies visited by the researcher was carried out. Individual actual average performance observed and recorded by the researcher and the factorial test study values from the three companies totaling thirty (30) workers was computed and tabulated into a useful form and used to generate the expected model needed and further analyzed to get the results that satisfy the three hypotheses.

4.1 General Outputs SPSS Regression Analysis

Table 4: Variables Entered/Removed

Model	Variables Entered	Variables Removed	Method
1	Safety; Energy; Repairs, Motivation; Training, Technology[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: All workers [Performance.]

European Journal of Business and Innovation Research
Vol.1, No.1, March 2013, pp. 44-71
Published by European Centre for Research, Training and Development, UK (www.ea-journals.org)

Table 5 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.998[a]	.996	.995	1.13549

a. Predictors: (Constant), Safety, Energy, Repairs, Motivation, Training, Technology.

Table 6 ANOVA[B]

Model		Sum of Sq.	df	Mean Sq.	F	Sig.
1	Regression	7095.712	6	1182.619	917.229	.000[a]
	Residual	29.655	23	1.289		
	Total	7125.367	29			

Table 7 Coefficients[a]

Model		Unstand.d Coeffs.		Stand'd Coeffs.	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	51.139	11.009		4.645	.000
	Energy	-.424	.199	-.087	-2.130	.044
	Training	-.556	.317	-.124	-1.754	.093
	Motivation	-.679	.235	-.174	-2.888	.008
	Technology	.773	.349	.222	2.216	.037
	Repairs	.539	.181	.175	2.982	.007
	Safety	.640	.313	.235	2.049	.052

a. Dependent Variable: Performance.

4.2 Graphical Representation of Data

The Data tabulated in table 6, was analyzed with EXCEL LINEST and SPSS Software and a graph drawn for the six independent variables with the dependent variable (performance). The SPSS software was used to create the XY-plot each for the six predictors (X_1 – X_6) against performance (P) (fig 1-6) for the thirty workers shown in table 6. This SPSS package, when customized, displays both

European Journal of Business and Innovation Research
Vol.1, No.1, March 2013, pp. 44-71
Published by European Centre for Research, Training and Development, UK (www.ea-journals.org)

the Model, values of correlation coefficients (R) and the value of the coefficient of determination (R^2) for each independent variable (X_i) plotted against performance (P). The is fit of a linear distribution and was tested, and it was found that the coefficient of determination R^2 was very good and is in the ranges from 0.883 to 0.987 (shown in tables 11, 14, 17, 20, 23 and 26), hence all the curves present good correlation coefficient R [$\sqrt{(R^2)}$].

THE GENERAL REGRESSION MODEL (from table 7)

$$\mathbf{P\ (X_i)} = 51.14 - .424X_1 - .556X_2 - .679X_3 + .773X_4 + .539X_5 + .640X_6 \qquad (16)$$

The percentage contributions of the factors effect on performance are calculated such that motivation = 18.80%, power/energy = 11.69%, safety = 17.72%, maintenance =14.93%, training = 15.40%, and technology = 21.41%.

4.3 SPSS- Model Summary, ANOVA, Parameters Estimates and Graphs

A) power/Energy SPSS outputs

Table 8. Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
.940	.883	.879	5.447

The independent variable is Power/Energy.

Table 9 ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Regression	6294.737	1	6294.737	212.192	.000
Residual	830.630	28	29.665		
Total	7125.367	29			

The independent variable is Power/Energy.

Vol.1, No.1, March 2013, pp. 44-71

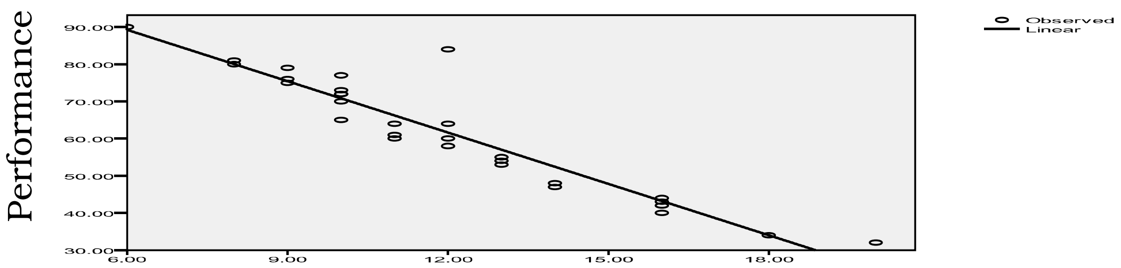
Published by European Centre for Research, Training and Development, UK (www.ea-journals.org)

Table 9 ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Regression	6294.737	1	6294.737	212.192	.000
Residual	830.630	28	29.665		
Total	7125.367	29			

Table 10 Coefficients

	Unstandardized Coefficients		Standardized Coeffs.		
	B	Std. Error	Beta	t	Sig.
Power/Energ	-4.604	.316	-.940	-14.567	.000
(Constant)	116.861	3.911		29.882	.000



Power/Energy

Fig 1: Performance Vs Power/Energy

B Training SPSS Outputs

Table 11 Model Summary

R	R Square	Adjusted R Square	Std. Error Estimate
.979	.959	.957	3.237

European Journal of Business and Innovation Research
Vol.1, No.1, March 2013, pp. 44-71
Published by European Centre for Research, Training and Development, UK (www.ea-journals.org)

The independent variable is Training

Table 12 ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Regression	6832.000	1	6832.000	652.071	.000
Residual	293.367	28	10.477		
Total	7125.367	29			

The independent variable is Training.

Table 13 Coefficients

	Unstandardized Coeffs.		Stand'd Coeffs.		
	B	Std. Error	Beta	t	Sig.
Training	-4.410	.173	-.979	-25.536	.000
(Constant)	115.710	2.194		52.749	.000

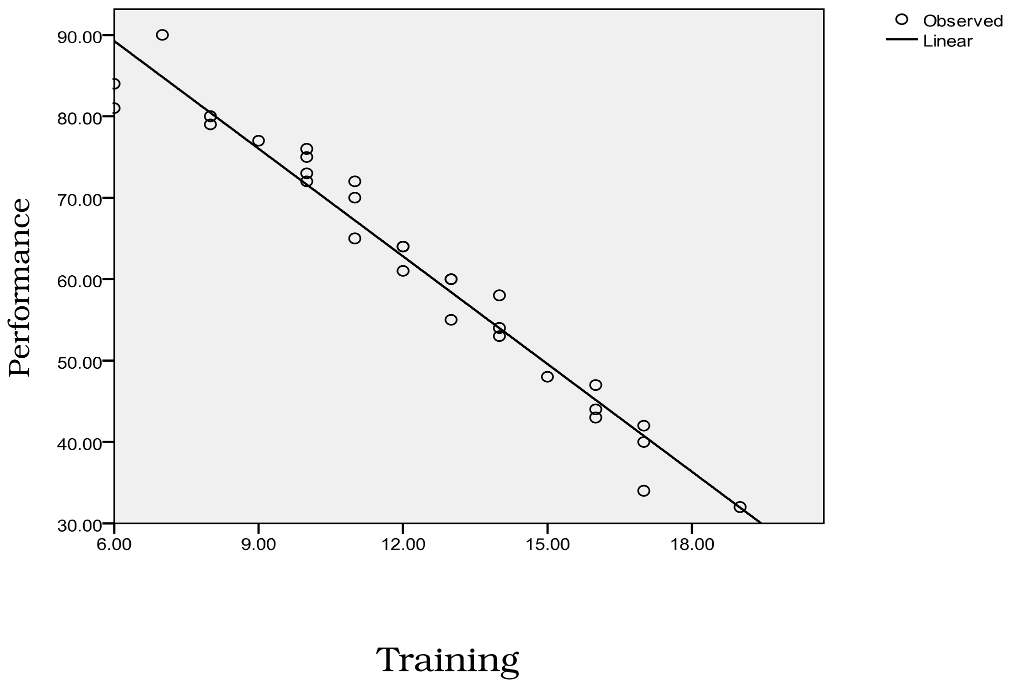


Fig2: Performance Vs Training

C – Motivation, SPSS Outputs

Table 14 Model Summary

R	R Square	Adjusted R Square	Std. Error Estimate
.977	.955	.953	3.390

The independent variable is Motivation.

Table 15 ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Regression	6803.551	1	6803.551	591.952	.000
Residual	321.816	28	11.493		
Total	7125.367	29			

The independent variable is Motivation

Table 16 Coefficients

	Unstandardized Coeffs.		Stand'd Coeffs.		
	B	Std. Error	Beta	t	Sig.
Motivation	-3.824	.157	-.977	-24.330	.000
(Constant)	108.542	2.020		53.741	.000

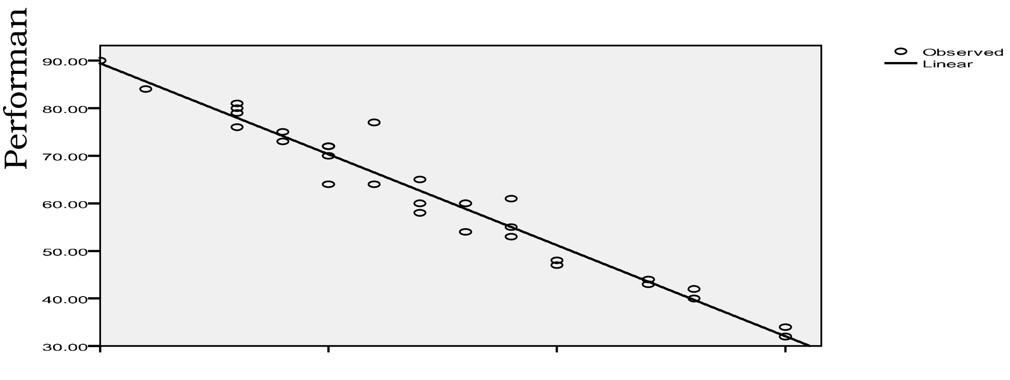


Fig 3: Performance Vs Motivation

D- Technology SPSS Outputs

Table 17 Model Summary

R	R Square	Adjusted R Square	Std. Error Estimate
.992	.985	.984	1.982

The independent variable is Technology.

Table 18 ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Regression	7015.324	1	7015.324	1785.023	.000
Residual	110.043	28	3.930		
Total	7125.367	29			

The independent variable is Technology

Table 19 Coefficients

	Unstandardized Coeffs.		Stand'd Coeffs.		
	B	Std. Error	Beta	t	Sig.
Technology.	3.463	.082	.992	42.250	.000
(Constant)	6.473	1.358		4.767	.000

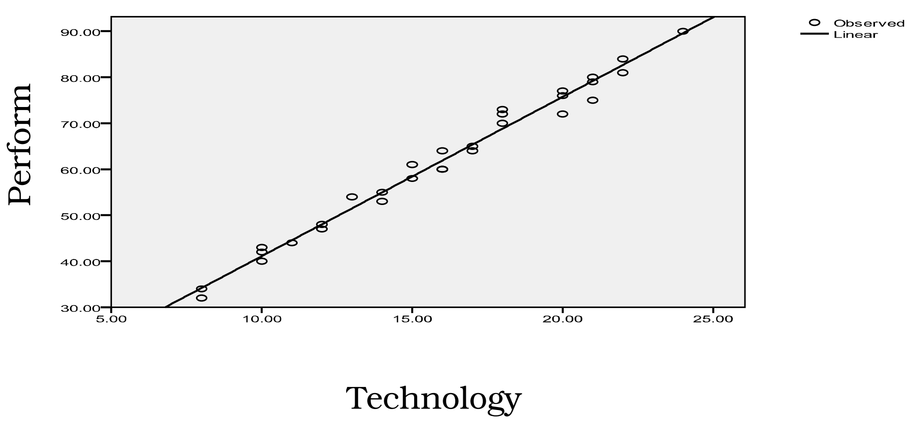


Fig 4: Performance Vs Technology

E- Maintenance/Repairs SPPS Outputs

Table 20 Model Summary

R	R Square	Adjusted R Square	Std. Error Estimate
.975	.950	.949	3.553

The independent variable is Maintenance/Repairs

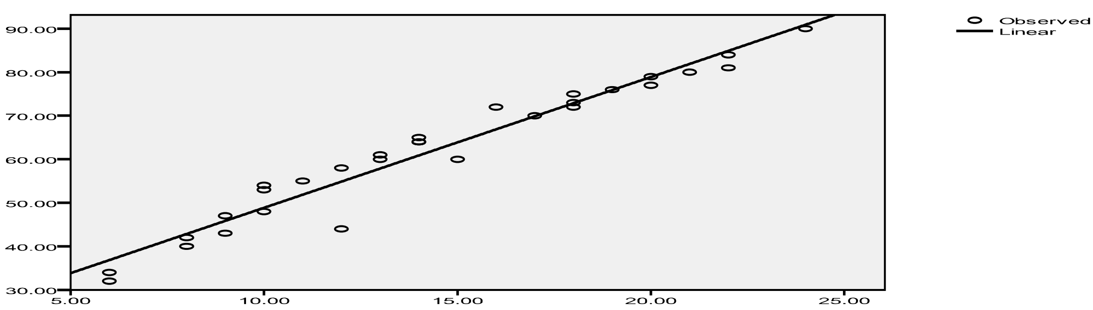
Table 21 ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Regression	6771.914	1	6771.914	536.460	.000
Residual	353.453	28	12.623		
Total	7125.367	29			

The independent variable is Maintenance/Repairs.

Table 22 Coefficients

	Unstandardized Coeffs.		Standard.d Coeffs.		
	B	Std. Error	Beta	t	Sig.
M/Repairs	3.004	.130	.975	23.162	.000
(Constant)	18.806	1.965		9.570	.000



Performance

Maintenance

Fig. 5: Performance Vs Maintenance / Repairs

European Journal of Business and Innovation Research

Vol.1, No.1, March 2013, pp. 44-71

Published by European Centre for Research, Training and Development, UK (www.ea-journals.org)

F - Safety, SPSS Outputs

Table 26 Model Summary

R	R Square	Adjusted R Square	Std. Error Estimate
.994	.987	.987	1.810

The independent variable is Safety.

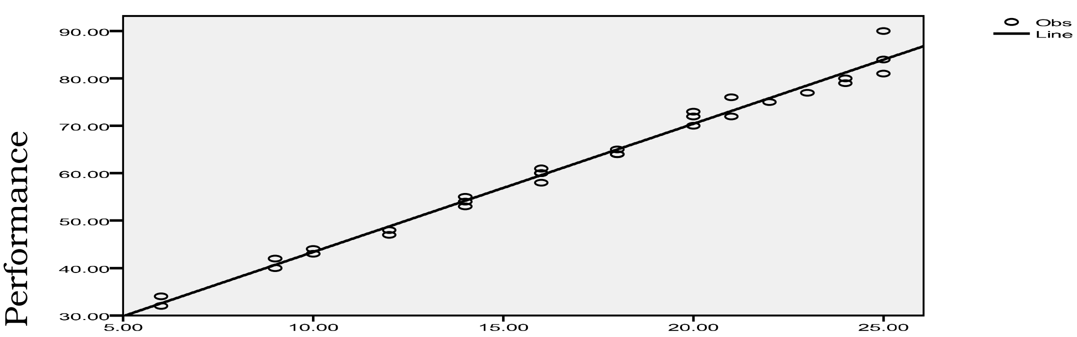
Table 24 ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Regression	7033.639	1	7033.639	2147.024	.000
Residual	91.728	28	3.276		
Total	7125.367	29			

The independent variable is Safety.

Table 25 Coefficients

	Unstandardized Coeffs.		Stand'd Coeffs.		
	B	Std. Error	Beta	t	Sig.
Safety	2.706	.058	.994	46.336	.000
(Constant)	16.312	1.035		15.758	.000



Safety

Fig 6: Performance Vs Safety

Table 26 Model Summary [b]

Model	R	R Sq.	Adj. R Sq.	Std. Err. Esti.	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.998[a]	.996	.995	1.13549	.996	917.229	6	23	.000	2.032

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

b. Dependent Variable: VAR00007

Table 27 ANOVA [b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7095.712	6	1182.619	917.229	.000[a]
	Residual	29.655	23	1.289		
	Total	7125.367	29			

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

b. Dependent Variable: VAR00007

Table 28 Coefficients [a]

Model		Unstand'd Coeffs.		Stand Coeff			95.0% Confid Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Zero order	Partial	Part	Tolerance	VIF
1	(Constant)	51.139	11.01		4.645	.000	28.366	73.912					
	VAR00001	-.424	.199	-.087	-2.130	.044	-.836	-.012	-.940	-.406	-.029	.110	9.124
	VAR00002	-.556	.317	-.124	-1.754	.093	-1.212	.100	-.979	-.343	-.024	.036	27.409

VAR00003	-.679	.235	-.174	-2.888	.008	-1.165	-.193	-.977	-.516	-.039	.050	19.951
VAR00004	.773	.349	.222	2.216	.037	.052	1.495	.992	.420	.030	.018	55.194
VAR00005	.539	.181	.175	2.982	.007	.165	.913	.975	.528	.040	.053	19.024
VAR00006	.640	.313	.235	2.049	.052	-.006	1.287	.994	.393	.028	.014	72.822

a. Dependent Variable: VAR00007

Table 29 Co linearity Diagnostics [a]

Model	Dim.	Eigen value	Condition Index	Variance Proportions						
				(Constant)	VAR001	VAR002	VAR003	VAR004	VAR005	VAR006
1	1	6.492	1.000	.00	.00	.00	.00	.00	.00	.00
	2	.491	3.635	.00	.00	.00	.00	.00	.00	.00
	3	.008	28.735	.00	.45	.10	.00	.01	.09	.00
	4	.005	36.567	.00	.31	.03	.50	.00	.18	.01
	5	.003	45.794	.00	.01	.23	.19	.02	.71	.07
	6	.001	82.410	.00	.01	.02	.00	.77	.01	.61
	7	.000	151.001	1.00	.22	.61	.31	.19	.00	.31

a. Dependent Variable: VAR007

Table 30a Correlations

		VAR007	VAR001	VAR002	VAR003	VAR004	VAR005	VAR006
Pearson	VAR007	1.000	-.940	-.979	-.977	.992	.975	.994

Correl.	VAR001	-.940	1.000	.898	.923	-.936	-.889	-.933
	VAR002	-.979	.898	1.000	.946	-.972	-.962	-.979
	VAR003	-.977	.923	.946	1.000	-.969	-.936	-.971
	VAR004	.992	-.936	-.972	-.969	1.000	.966	.988
	VAR005	.975	-.889	-.962	-.936	.966	1.000	.968
	VAR006	.994	-.933	-.979	-.971	.988	.968	1.000

Table 30b Excluded Variables[e]

Model		Beta In	T	Sig.	Partial Correl	Collinearity Statistics		
						Toleance	VIF	Minimum Tolerance
1	VAR001	-.102[a]	-1.778	.087	-.324	.130	7.686	.130
	VAR002	-.163[a]	-1.609	.119	-.296	.042	23.629	.042
	VAR003	-.213[a]	-2.577	.016	-.444	.056	17.782	.056
	VAR004	.445[a]	3.918	.001	.602	.024	42.414	.024
	VAR005	.209[a]	2.721	.011	.464	.063	15.832	.063
2	VAR001	-.057[b]	-1.149	.261	-.220	.122	8.225	.022
	VAR002	-.111[b]	-1.314	.200	-.250	.041	24.290	.018
	VAR003	-.148[b]	-2.058	.050	-.374	.052	19.055	.021
	VAR005	.149[b]	2.212	.036	.398	.059	16.989	.021
3	VAR001	-.086[c]	-1.868	.073	-.350	.115	8.695	.020
	VAR002	-.070[c]	-.832	.413	-.164	.038	26.078	.017
	VAR003	-.175[c]	-2.721	.012	-.478	.051	19.488	.018
4	VAR001	-.073[d]	-1.762	.091	-.338	.114	8.810	.017
	VAR002	-.096[d]	-1.291	.209	-.255	.038	26.466	.014

a. Predictors in the Model: (Constant), VAR006

b. Predictors in the Model: (Constant), VAR006, VAR004

c. Predictors in the Model: (Constant), VAR006, VAR004, VAR005

d. Predictors in the Model: (Constant), VAR006, VAR004, VAR005, VAR003

e. Dependent Variable: VAR007

4.0 Discussion of Results

4.1 Graph's Summary.

From above graphs and model summaries, it is vividly seen that all the plottings are linear with good coefficient of determinations R^2 hence a good correlation coefficient which summarizes that all the predictors or independent variables affects performance of manufacturing workers. Again, the graphs clearly proves that the predictors-Power/Energy, Training and motivation affects performance negatively while Technology, maintenance/Repairs and safety affects workers performance positively.

4.2 Discussion of Results Generated in SPSS

Abinitio, the objective of this work is to find the relationship between the predictors (independent variables) and performance of the production worker in a manufacturing industry. A regression analysis was carried out on the data of tables 3, 4, 5, and table 6 which was obtained from the three companies under study. The model summaries of the regression analysis on these Factorial data (Table 29) indicate that the regression models have good coefficients of correlation between 0.999 and 1.000 and their coefficients of determination between 0.998 and 0.999.

The ANOVA tables of table 9 and 30, show good significance of the predictors evaluated at the three companies with a 95% confidence interval i.e. 0.05 significant levels. The multi-linear regression models developed from these analyses are given as follows:

For Louis Carter:

$$Y = 0.744x_1 + 0.840x_2 - 0.057x_3 + 1.472x_4 - 0.099x_5 + 02.357x_6 - 18.235 \quad (16)$$

For Sun Flower:

$$Y = 0.602x_1 - 1.114x_2 - 1.450x_3 + 0.265x_4 + 0.656x_5 + 0.038x_6 + 86.789 \quad (17)$$

For Millennium:

$$Y = -0.466x_1 - 0.965x_2 - 0.292x_3 + 0.492x_4 + 0.512x_5 + 0.927x_6 + 52.064 \quad (18)$$

At the combination of all the performance data for the three companies, the multi linear regression model (Table 10) is given as;

$$Y = -0.424x_1 - 0.556x_2 - 0.6799x_3 + 0.773x_4 + 0.539x_5 + 0.640x_6 + 51.139 \quad (19)$$

From the standardized coefficient column of the coefficients tables (tables 13, 16, 19, 22, 25, and 28) for the individual company and all companies combined (table 10), it is observed that the predictor safety has the most positive contribution to the manufacturing workers performance. This means that all the company lays good emphasis on safety in achieving its production.

4.3 Co linearity Diagnostics

The combined data of table 34 shows that there might be a problem with multi-co linearity. For most of the predictors, the values of the partial and part correlations dropped sharply from the zero order correlation (see table 31). This means, that much of the variance in energy that is exhibited by all workers in their performance is also exhibited by other predictors or independent variables.

The tolerance is the percentage of the variance in a given predictor that cannot be explained by the other predictors. When the tolerances are close to 0, there is high multi co linearity and the standard error of the regression coefficient will be inflated. A variance inflation factor (VIF) greater than 2 is usually considered problematic and the smallest in the table is 9.124, hence the co linearity diagnostics confirms that there are serious problems with multi co linearity.

Several Eigen values are close to 0 indicating that the predictors are highly inter correlated and that small changes in the data values may lead to large changes in the estimates of the coefficients.

The condition indices were computed as the square roots of the ratio of the largest Eigen values of the each successive Eigen value. A value greater than 15 indicates a possible problem with co linearity, greater than 30, a serious problem. Four of these indices are larger than 30, suggesting a very serious problem with co linearity.

4.4 Solving the Problem of Co linearity

In order to fix the co linearity problem we rerun the regression analysis using z –scores of the dependent variables and the stepwise method of the predictor's selection (Table 32). This is to include only the most positive contributing variables to the dependent variable (performance) in the model. After the elimination or exclusion process, the predictors; safety, technology, maintenance/repairs, and motivation are the variables left over in descending order of significance.

The predictors, Power/Energy and Training are the variables excluded from the model (Table 32). This is an excellent indication that all the manufacturing companies under study have serious problem with their energy, training and somewhat motivation programmes. Hence, the poor availability of Energy, Training and sometimes motivation to the production workers affect performance negatively, thereby requiring improvement to make production process highly efficient and profitable.

4.5 Coefficient of Determinations R^2 and F- Distribution Statistics

The coefficient of determination "R^2" of the model summary as seen in table 16 is 0.996, which is approximately equal to one and indicates a strong relationship between the independent and the dependent variables.

The-F- Statistical distribution can now be used to determine whether these results, or model, with such a high R^2 value occurred by chance. The term alpha is used for the probability of erroneously concluding that there is a relationship. Assuming an alpha of 0.05, the F – distribution of 917.229 at DF of -23- in both SPSS and Excel LINEST output as seen in tables 10 and 34 respectively could be used to assess the likelihood of a higher "F" value occurring by chance.

Referring to the "F" statistical distribution table, an appropriate – F- distribution has V_1 and V_2 degrees of freedom while n=number of data points. From table 34, $V_1 = n – df – 1 = 23$ and $V_2 = df =6$.

Hence, from the statistical table, the critical value of "F" distribution at the above stated points is 2.53, while the "F" returned by LINEST and SPSS at same points as seen in Table 34, 35 and 10 is 917.229, which is far above 2.53 and these occurred with a high coefficient of determination R^2 = 0.996.and correlation coefficient (R) =0.998

To proof that this large value of "F" (917.229) did not occur by chance, Excel FDIST was employed (FDIST(F, V_1, V_2) to calculate the probability of a large F-value of 917.229 not occurring by chance, and it was found to be 1.76408 X 10^{-26}. This probability value is very small, showing that the result did not occur by chance. With alpha = 0.05, the earlier stated null hypothesis Ho, that the results obtained occurred by chance is hence rejected, while the alternative hypothesis H_1, that the results obtained did not occur by chance is accepted.

From above, the researcher conveniently concluded that there are relationship between the manufacturing workers performance and the six independent variables in consideration since – F – value of 917.229 exceeds critical level of 2.53, and the probability of it not occurring by chance is very negligible, 1.76408 X 10^{-26} (i.e. 0.000).

4.6 The – t – Critical Values Statistical Distribution Test.

Again from the results obtained, another good hypothetical test could be to determine whether each slope coefficient (m) is useful in predicting the model generated. This could be achieved using the statistical "t" critical distribution test. Generally $t_i = m_i/s_{ei}$ and from the statistical t- table, t – critical

European Journal of Business and Innovation Research
Vol.1, No.1, March 2013, pp. 44-71
Published by European Centre for Research, Training and Development, UK (www.ea-journals.org)

for one – tailed distribution with 23 degrees of freedom and alpha of 0.05 is given as 1.714 (in t-distribution table).

If the absolute values of "t" returned in the linear regression model generated from the six predictors against 30 workers performance by Excel LINEST and SPSS software as seen in tables 29 and 10 are all greater than the – t - critical for the same points from the statistical – t- distribution tables. Which is (1.714), then it means that their various slope coefficients (m_i) can conveniently be used to predict the model generated.

These values of – t- shown in tables 10 and 29 have an absolute value greater than 1.714, therefore, all the variables used in the regression model are useful in predicting the performance of manufacturing workers in industries.

5.0 Conclusion and Recommendation

5.1 Conclusion

The study has been able to identify the relationship between the production workers performance and the six predictors and also predicted a regression model after careful study of activities, functions, and program of three selected plastics industries. The model if improved and applied will help to address the problems arising from those factors effects on workers performance. It was discovered that the six factors considered, actually affect the performance of the manufacturing workers in those industries. Also the slope coefficients in the models (equations 16 to 19) are adequate enough to predict manufacturing workers performance. These results obtained did not occur by chance due to its negligible probability of $1.76408E^{-26}$ (0.000).

It is imperative to realize that performance goals and targets set in industries can only be achieved when our industries handle the issues of workers performance as relate to constant power supply, adequate training, high motivation, safety of workers, proper and urgent maintenance/repairs of machines as well as constant technology upgrading. Finally, the models were generated using multi linear regression analyses in SPSS and EXCEL LINEST software, and made available for industrial consumption.

In trying to solve the problem of collinearly the study draws the attention of our industrialist on huge neglect to workers Training, motivation and importance of constant power supply to efficiency of production workers and hence achieving target in productivity.

5.2 Recommendations

The constraints and Problems identified in the study greatly affected the performance of workers which partly explain the reasons behind the not-so-good performance recorded by the industries during the period of the study.

The following actions are therefore recommended for our industrialists and government.

(a) Management should, through the budgeting and the assignment of responsibility, create an environment which allows the workers to develop and use their full potential through constant trainings and excellent motivation. Employers should introduce incentive schemes that will ensure manufacturing workers commitment towards achieving minimum cost and high productivity to the organization.

(b) Improvement in infrastructures such as constant supply of electricity or other alternative sources of power supply to industries are quite necessary to workers effective performance. Here comes the need for the assistance of our government. The on-going reforms in the power sector should be effectively and efficiently implemented without further delay so as to address epileptic power supply problem in industries.

(c) Finally, industries are advised to study and apply the result of the regression analyses carried out in this work and improve on those factors where necessary and use it appropriately to address most problems associated with the predictors as it relates to manufacturing workers performance.

5.3 Contribution to Knowledge

i It serves as an indispensable guide to companies, both public and private in handling these predictors and manufacturing workers to achieve optimum profitable productivity.

ii The work done here stands as a pace setting tools for more research work on other predictors as they affect manufacturing workers and performance.

Reference

Borman, W.C. (2004), 'The concept of organizational citizenship', *Current Directions in Psychological Science*, 13(6), 238-241
Beeley H.(1977), Industrial Management Services, Macdonald and Evans, Eastover, Plymouth, pp 92 – 152, 169 – 172
Luthans, F. (1998), *Organizational behavior* (8th edition), Boston, Texas: Irwin McGraw-Hill.
Wayne W.D (1977), Introductory Statistics with Applications, Houghton Mifflin Company, Boston,

APPENDIX

Table 1: Workers Average Daily % Performance (P) and Computed Data from Factorial Test Study Sheets (from Louis Carter Company)

Company workers	Power X_1	Training X_2	Motivation X_3	Technology X_4	M/repairs X_5	Safety X_6	Performance P
L_1	13	14	13	13	10	14	54
L_2	11	13	13	16	15	16	60
L_3	14	15	15	12	10	12	48
L_4	16	17	18	10	8	9	42
L_5	18	17	20	8	6	6	34
L_6	8	6	8	22	22	25	81
L_7	8	8	8	21	21	24	80
L_8	10	10	10	20	16	20	72
L_9	11	12	10	16	14	18	64
L_{10}	10	11	10	18	18	21	72

Table 2: Workers Average Daily % Performance (P) and Computed Data from Factorial Test Study Sheets (from Sunflower Company)

Company workers	Power X_1	Training X_2	Motivation X_3	Technology X_4	M/repairs X_5	Safety X_6	Performance P
S_1	10	10	9	18	18	20	73
S_2	13	13	14	14	11	14	55
S_3	16	17	18	10	8	9	40
S_4	12	13	12	16	13	16	60
S_5	16	16	17	10	9	10	43
S_6	12	12	11	17	14	18	64
S_7	9	8	8	21	20	24	79
S_8	12	14	12	15	12	16	58
S_9	6	7	5	24	24	25	90
S_{10}	10	11	10	18	17	20	70

Table 3: Workers Average Daily % Performance (P) and Computed Data from Factorial Test Study Sheets (from Millennium Plastics)

Company workers	Power X_1	Training X_2	Motivation X_3	Technology X_4	M/repairs X_5	Safety X_6	Performance P
M_1	20	19	20	8	6	6	32
M_2	16	16	17	11	12	10	44
M_3	10	11	12	17	14	18	65
M_4	14	16	15	12	9	12	47
M_5	11	12	14	15	13	16	61
M_6	13	14	14	14	10	14	53
M_7	9	10	8	20	19	21	76
M_8	9	10	9	21	18	22	75
M_9	12	6	6	22	22	25	84
M_{10}	10	9	11	20	20	23	77

Ten Manufacturing Workers Performance[Time Studies] Data Observed and Recorded for Six Days (Louis Carter L_1- L_{10})Name of Section: Injection

S/N	Day	Machine or company's fixed maximum daily production capacity for 8hrs	Actual quantity produced each day by the worker	Workers or individual performance each day (P_1-P_6)	Average – percentage performance (P) per week
1		**Workers L_1 on Machine One**			
		Item Produced, – 5-Arms Fan Blade			
	1	196 pcs	116	$P_1 = 0.592$	3.256/6
	2.	√	114	$P_2 = 0.582$	
	3.	√	140	$P_3 = 0.714$	0.543
	4.	√	78	$P_4 = 0.399$	
	5.	√	140	$P_5 = 0.714$	54%
	6.	√	50	$P_6 = 0.255$	
2.	**Workers L_2 on Machine Two**				
	Item Produced, Front Fender – CG 125 Brand				

	1.	211pcs	216	$P_{1} =$ 1.024	3.573/6
	2.	√	175	$P_{2} =$ 0.829	
	3.	√	105	$P_{3} =$ 0.498	
	4.	√	94	$P_{4} =$ 0.445	0.596
	5.	√	84	$P_{5} =$ 0.398	
	6.	√	80	$P_{6} =$ 0.379	60%
3.	**Workers L_3 on Machine Three**				
	Item Produced, Back Fender – CG 125 Brand				
	1.	480pcs	218	$P_{1} =$0.454	2.887/6
	2.	√	261	$P_{2} =$ 0.544	
	3.	√	218	$P_{3} =$ 0.454	0.481
	4.	√	305	$P_{4} =$0.635	
	5.	√	204	$P_{5} =$ 0.425	48%
	6.	√	180	$P_{6} =$ 0.375	

[