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Determination of Combined Effects of Factors that Affect Performance Operatives in Manufacturing Industries, Using Minitab

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ABSTRACT: *This research work determines the degree of impact of some factors in their combined state and interactions effects on the performance of operatives (manufacturing workers) in manufacturing industries. Factors studied include: motivation, power, safety, maintenance, training, equipment and technology. Eighty-two manufacturing workers drawn from thirteen manufacturing Plastic Companies were used. Data were collected using work measurement technique (time studies) and questionnaire (tests studies). Software is used for the various analyses in the study. The software used was Minitab. Software tools used for various analyses in the study are: statistics, correlation, polynomial regression and response surface regression, while t – value, F- ratio, p – values, effect coefficient and variance of inflation factors (VIF) were used to test the hypotheses. Results from the various statistical analyses were presented, studied and interpreted. The results showed that the identified factors have impact on the performance of the manufacturing workers in the plastic manufacturing industries. The fall in performance of manufacturing workers in plastic industries is due to these cumulative effects of factors. The magnitude of these effects of the combined and interactions on performance are 42.57% ($\alpha = 0.15$), 43.67% ($\alpha = 0.1$) and 43.67% ($\alpha = 0.05$). The effect reduces as confidence interval increases above 90%. The correlation coefficients of the factors to performance are all showing positive linear effects while the regression model coefficients some show negative effects. The models developed in quadratic shape factor are valid in predicting performance and their combined and interactions effects apparently providing information for controlling problems arising in manufacturing workers performance in industries in the South Eastern Nigeria and any other place.*

KEYWORDS: Performance, Manufacturing Workers, Industries, Factorial Indices and Regression Models.

INTRODUCTION

Background of the Study

Manufacturing in Nigeria has not been progressive to the intent of its establishments. A lot of setback occurred to companies and the national economy. Researchers have been done on singular factors to find why non-performing of the manufacturing workers in their work places. There is then, the need to determine the factors that affect the performance of individual manufacturing operatives in firms in South Eastern Nigeria. To consider many factors combined to see their contribution in affecting performance in manufacturing.

Seven factors were chosen for the investigations and the selected factors are: motivation, power, safety, maintenance, training, equipment and technology and data were generated through the questionnaire (tests) and work measurement (times) studies, which were analyzed to produce results and multi - regression models were developed that predicted the performance.

Statement of Problem

The poor state of manufacturing in Nigerian manufacturing industries and the prevailing manufacturing environmental factors effects in industry have resulted to too many problems to the manufacturing sectors- the epileptic electric power supply which resulted to many companies folded or relocated to another region or country; manufacturing conditions posed many challenges to directors and managers of Companies; workers challenges such as poor salary, irregular payment of salaries and provision of standard facilities are factors responsible to the existing problems and the poor quality of motivation factor to the manufacturing workers hinders their commitment to work.

Justification of the Study

The study looked into the general problems of non performance of manufacturing workers in manufacturing companies. In the effort to tackle the general problems of non performance of manufacturing workers a lot of concerned scientists delved into finding the actual causes of the problems, as men like: Alimi Baba Gana et al, (2011) on the effects of motivation on workers performance shows that motivational incentives given to workers in an organization has a significant influence on the workers performance. Gure, Naima Abdullahi (2010) study on '*The Impact of Motivation on Employee Performance':* investigated whether there is any relationship between motivations, job satisfaction and employee performance. In the review of the past work there are efforts of men who sort to discover reasons for non performance of workers in industries, as to be the effects of factors that affect manufacturing in industries which were investigated singularly, but this is to be reviewed in "factors – combined- states" to see their significance in contribution to the general problems of non performance in production.

Hence, the study investigated the factors in their combined state and interactions to see if there is any significant effect on the performance of manufacturing workers in manufacturing industries.

It is pertinent to have solutions to the problems of non performance of the manufacturing workers, the results of the analyses when analyzed the various parameters that characterized performance, affectivity and efficiency in manufacturing industries give the solutions.

The results obtained reveal the significance and interactions effects of the factors on performance and their essence in engineering management applications.

Research Hypotheses

The following null hypotheses (H_0) were drawn to enable the research validate its various responses emanating from the field work.

H_{01}: That the performance of manufacturing workers in industries

is not affected by Motivation, Power and Energy, Maintenance,

Safety, Training, Equipment and Technology

H_{02}: That the Coefficients of the independent variables of the regression models are not good enough to predict the model.

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H_{03}: That the combined state and interactions effects of factors have no impact on performance

H_{04}: That the quantitative values of the results obtained from the various parametric measurements of the factors do not fit adequately in establishing the manufacturing workers performance characteristics.

Objectives of the Study

Main Objective of the Study

To determine the combined effect of the factors that affects the performance of operatives (manufacturing workers) in manufacturing industries.

Other Objectives of the Study include:

I. To identify critical factors such as: motivation, power / energy, safety maintenance, training, equipment and technology that affect the performance of manufacturing workers in industries

II. To determine the degree of impact of such factors in the performance of manufacturing workers;

III To develop and validate models those predict the performance of the manufacturing workers

IV. To apply the developed models and factorial indices in solving engineering management problems, decision making, and other organizational policy formulations; and

V To provide relevant pieces of information for the improvement of work force (workers) performance

Scope of the Study

1. Selection of factors that probably affect manufacturing workers performance in industries in South Eastern Nigeria, such as: motivation, power, safety, maintenance, training, equipment and technology.
2. Limited to discrete product of manufacturing- secondary or consumer goods industries.
3. Discrete products of plastics manufactured through the manufacturing processes of blowing, injection and extrusion are applied.
4. Major data only collected through the tests and time studies.
5. Software Analyses (in Minitab) of the data to obtain results which were discussed to conclude the study.

Limitation of the Study

1. It is difficult to have sufficient standard operatives that will serve the purpose.

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2. Constant power outage of electricity in the day to day activities thereby resulting in insufficient data measurements and collection.

3. No synergy between industrial establishments and Universities for easy flow of information that will create enable environment for research, innovation and development (RID).

4. High Cost in procuring and processing research data.

LITERATURE REVIEW

Review of the Past Work

Employees' performance in the industries has attracted the attention of many researchers and these researchers reported on the various conditions that affect workers in their work places and enunciated ways of handling environmental conditions to enhance efficiency of the workers. From the work of Iwuoha, (2005) on predicting the Productivity of Female Maintenance Engineers in Manufacturing Industries in Nigeria, using such Factorial Indices as Education, Team Work, Marital Status and Courage; it was found that female maintenance engineers who work in the industries are affected by the above identified predictors. He further pointed out that human behaviours are unpredictable, one would expect female maintenance engineers working in the manufacturing industries in Nigeria to have some unique conditions to contend with which may be social, cultural or political. This study confirms that the chosen parameters, education, team-work, marital status and courage can be used as the Predictors of the Productivity of the female maintenance engineer in manufacturing industries in Nigeria. From the work of Dean Tjosvold et al, (2006) on the effects of power concepts and employee performance on managers' empowering, employees often do not feel that their managers assist and support them and that traditional views of power as limited and the involving overcoming resistance may seriously obstruct empowerment efforts. Gure, Naima Abdullahi (2010) Study on '*The Impact of Motivation on Employee Performance':* investigated whether there is any relationship between motivations, job satisfaction and employee performance. They used a quantitative data, which was processed using multivariate descriptive statistic (such as frequency and percentage) to describe the respondent's profile such as their gender, age, marital status and job title. Correlation and multiple regressions were used for inferential statistics. The Pearson correlation used, measures the significance of linear relationship between the independent and dependent variables. Multiple regressions were used to determine the relationship between independent and dependent variables, the direction, degree and Strength of the relationship.

The study of Alimi Baba Gana et al, (2011) on the effects of motivation on workers performance shows that motivational incentives given to workers in an organization has a significant influence on the workers performance. This is in line with equity theory which emphasizes that fairness and equality in the distribution of incentive packages tend to produce higher performance from workers (Alimi, 2002). The Findings also agree with the works of Berjum and lehr (1964) in Ajila and Abiola (2007) which showed that workers who received incentives performed better than those who did not. And also workers exhibited productive work behavior when motivational incentives were made contingent upon performance. The work also corroborated the findings of this study. He observed that poor motivation in relation

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to profits made by organization were differentials between high and low income earners among other things, contributed to low morale, lack of commitment and low productivity. From the work of Liao et al (2011) on Work values, work attitude and job performance of green energy industry employees in Taiwan that aimed to explore the relations among work values, work attitude (including job involvement and organizational commitment) and job performance, and explore how the director's leadership could serve as a moderator between work values and work attitude of the employees in which they considered these phenomena: Correlation between work values and work attitude; Correlation between work attitude and job performance; Correlation between work values and job Performance; mediating effects of work attitude on work values and job performance and moderating effects of leadership styles on work values and work attitude.

Inegbenebor et al (2002) worked on a survey of safety practices in some manufacturing industries in the North eastern state of Nigeria. They observed that lack of maintenance resulted to 22-50% of the industrial accidents, while most accident cases can be eliminated if the management of a company takes safety serious.

Oladokun et al (2007) investigated an ergonomic and safety evaluation of footwear used by male industrial workers in Nigeria. The study focused on the suitability and comfort ability of industrial shoes used in a typical Nigerian factory. Comparing some features they found that 60% feet feel suitable within the international accepted suitable standards of EN345, EN346 and EN347 for safety shoes, protective shoes and work shoes respectively. Uhunmwangho et al (2001) investigated the management of electric power in Nigeria. Their discussion on the strategies for electricity demand-side management (DSM) (2005), gave insight in power shortages, potentials for electricity conservation and measures to cope with the problems. Akinbami et al (2001), worked on the ways of improving efficiency of energy use in Nigeria's Industrial sector and observed that a sound industrial energy improvement implementation programme should be put in place at the national level. They suggested management commitment to energy improvement at the firm level, use of planning strategies, development of adequate process data and commitment at national level to energy management.

Igboannugu et al, (2002) worked on the anthropometric survey of the adult working class, whereby a concise anthropometric data of the working class within the age bracket of 18-65 years was given. Udosen et al (2003) worked on the automation in Nigeria manufacturing companies, and found that automation in the manufacturing companies is distributed as, 67% by multinationals and 33% by indigenous manufacturing Companies. Automation by its disposition increases performance and productivity.

Summary of Literature

Employees' performance in the manufacturing industries has attracted the attention of many researchers and these researchers worked and reported on the various conditions that affect the manufacturing workers in their work places and enunciated ways of handling the environmental factors to enhance the efficiency of the workers. From the above reviewed past work and many other work done by other engineering management scientists, it was discovered that most work that were done on the factors affecting workers performance were mostly by a single factor analysis only and nothing for many factors in combination and interactions of one or more factors effects on performance of manufacturing workers.

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The combined- effects of factors in the present study is considered to develop the factorial indices of the factors affecting manufacturing workers.

The concept of co-linearity diagnostics also investigated in the study to identify and isolate the irrelevant factors, and

Development of models and validations to use in prediction of performance

RESEARCH METHODOLOGY

Materials and Methods

a. Typical industries chosen: Plastic bottle blowing, Plastic Extrusion and Plastic Injection.
b. Skilled operators selected four-eight each from the chosen industries and Companies.
c. Instruments and Instruments Validation for Data collections.
d. Work measurements (time study) on the operators carried out for 6 days to generate data for the analyses.
e. Factors quality points measurements (tests study) from each chosen worker.
f. Statistical analyses of the data collected.
g. Development of models, inferences (significance and co-linearity diagnosis) and discussions.

(*Returning to the aim, objectives and hypotheses)*

Analytical Tools Employed

Mathematical tool, Performance $= \dfrac{\text{Total standard minutes allotted x100}}{\text{No of minutes to produce them}}$

Or $\dfrac{\text{Total weight produced} \quad \text{x } 100}{\text{Total standard weight to consume}}$ (1)

The average performance for the six days (P) was calculated. Machine daily maximum capacity is given

Maximum capacity per day = $\dfrac{\textbf{Daily working hour}}{\textbf{Cycle time}}$ (2)

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$$\therefore \text{Cycle time} = \frac{\textbf{one hour}}{\textbf{Max. Capacity per hour}} \qquad (2b)$$

The type of software used in the analyses is Minitab package.

Software tools used for various analyses in the study are: statistics, correlation, multi – linear - regression, response surface regression and polynomial regression, while t – value, F- ratio, p – values and variance of inflation factors (VIF) were used to test the hypotheses results.

Instruments for Data Collection (IDC)

The instruments used for data collection include the use of Time Study (Industrial operations monitoring and measurement of the Operators) and Test Study (questionnaire) **-** provides information about what people do, have, think, know, feel or want; and the information feedback is quantified using the Spit's Liker scale (test study) analysis and display as shown in tables (appendix A).

Another aspects of instruments used for the study was the work measurement and monitoring of operations carried out by operators (Time Study), measuring the various events or effects on elements of manufacturing and quantitatively expressed for use in analyses from which we obtain the factorial indices and prediction models. The Seven basic factors (motivation, power, and maintenance, Safety, Training, Equipment and Technology) were investigated for the various operators used in the experiments (applying the control and the experiments).

How Industrial Data Were Generated

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

I For a chosen industry, certain numbers of manufacturing workers were selected as the specimens for the study which is fixed to be 3, 4, 8, and 9 as the case may be for all the Companies.

II The chosen manufacturing workers were specifically monitored in their daily operations for **six** days of operation. Records were taken based on their daily output in respect to possible maximum output.

III Each of the chosen Operators were given Test Study tagged A_1, A_2, A_3, ... A_n, for company A; B_1, B_2, B_3, ... B_n, for Company B; and so on.

IV Answers from respondents (Operators) on the **SEVEN** selected factors (rated according to Spit's Liker Scale), were summed up and recorded respectively for each of the factors and Operators.

V The average values of the calculated performances of Operators in the six days monitor are tabulated correspondingly with the Respondent's Test study result as shown in table 3.1.

Determination of Coefficients

Determination of Correlation Coefficients

Correlation is a body of knowledge of relationship that exists between one variable and another variable(s).

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The equation for the correlation coefficient is:

$$\text{CORREL}(X,Y) = \sum(\mathbf{X}-\dot{\mathbf{X}})(\mathbf{Y}-\dot{\mathbf{Y}}) / \sqrt{\{\sum(\mathbf{X} - \dot{\mathbf{X}})^{\wedge}2(\mathbf{Y}-\dot{\mathbf{Y}})^{\wedge}2\}} \qquad \mathbf{(3)}$$

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

The values of Co-efficient of Correlation obtained in the calculations on the various treatments show that all maintenance values are positive correlation and there is a degree of correlation between the factors and the Performance of manufacturing workers, as shown:

Determination of Coefficient of Determination, R^2

This determines the extent to which the independent variable X is able to determine the dependent variable Y.

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

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

RESULTS AND DISCUSSIONS

Results

Critical Analysis of the Overall Data

a)

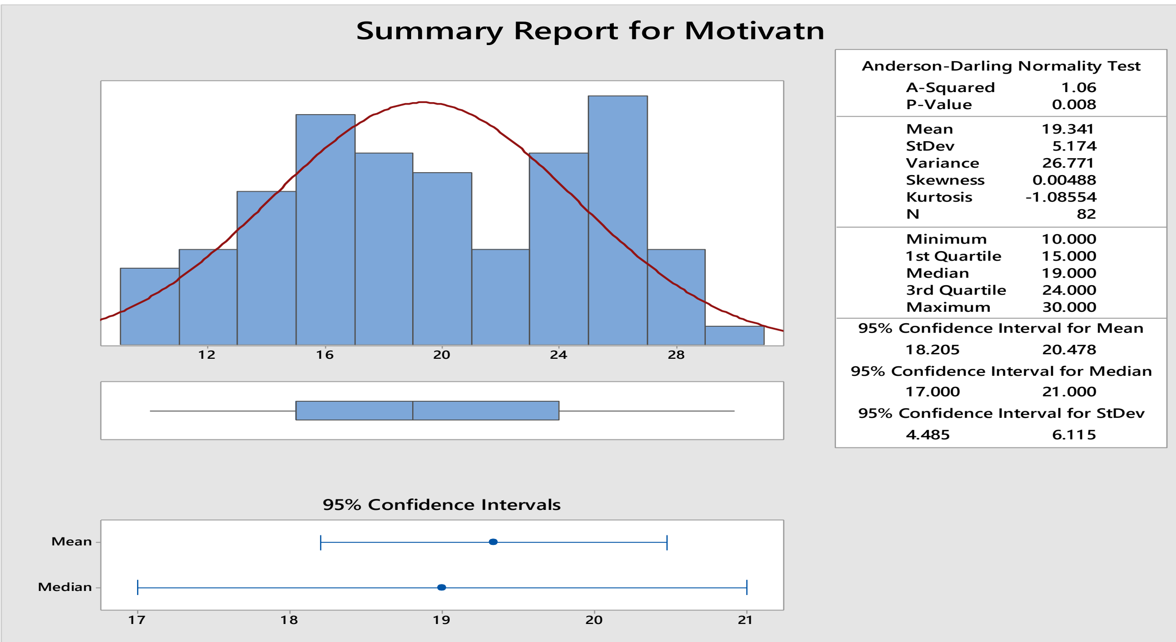

Fig. 1: SAS Print Out of Statistic Summary Report of Motivation

b)

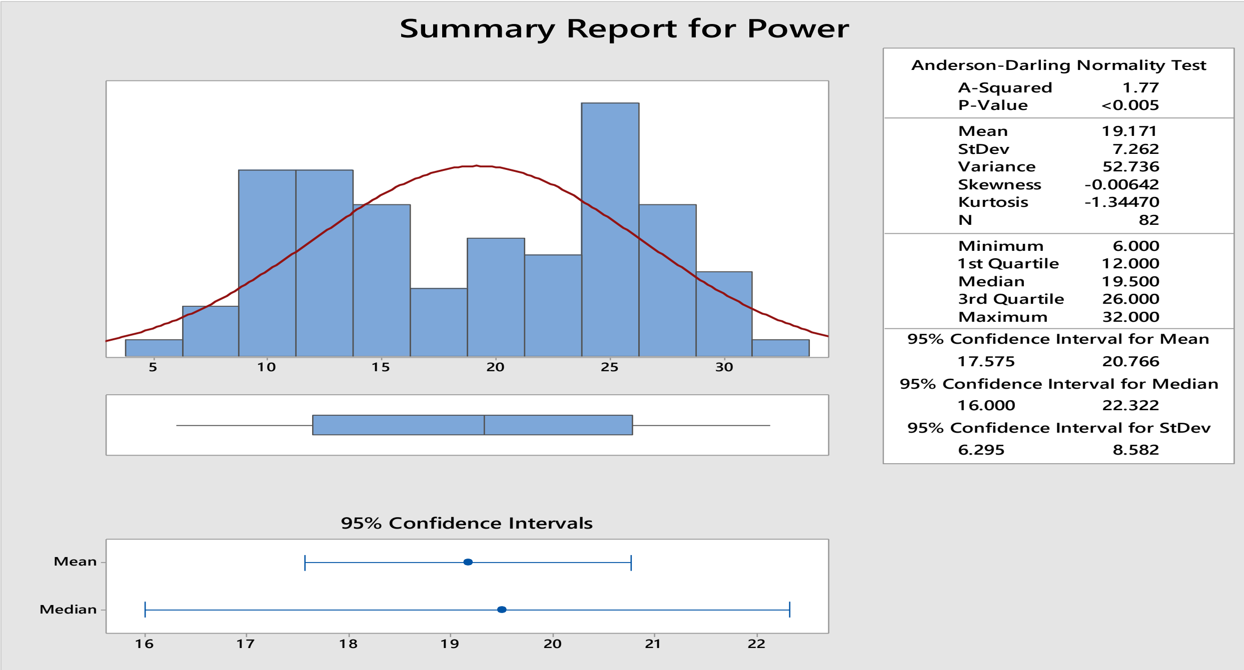

Fig. 2: SAS Print Out of Statistic Summary Report of Power

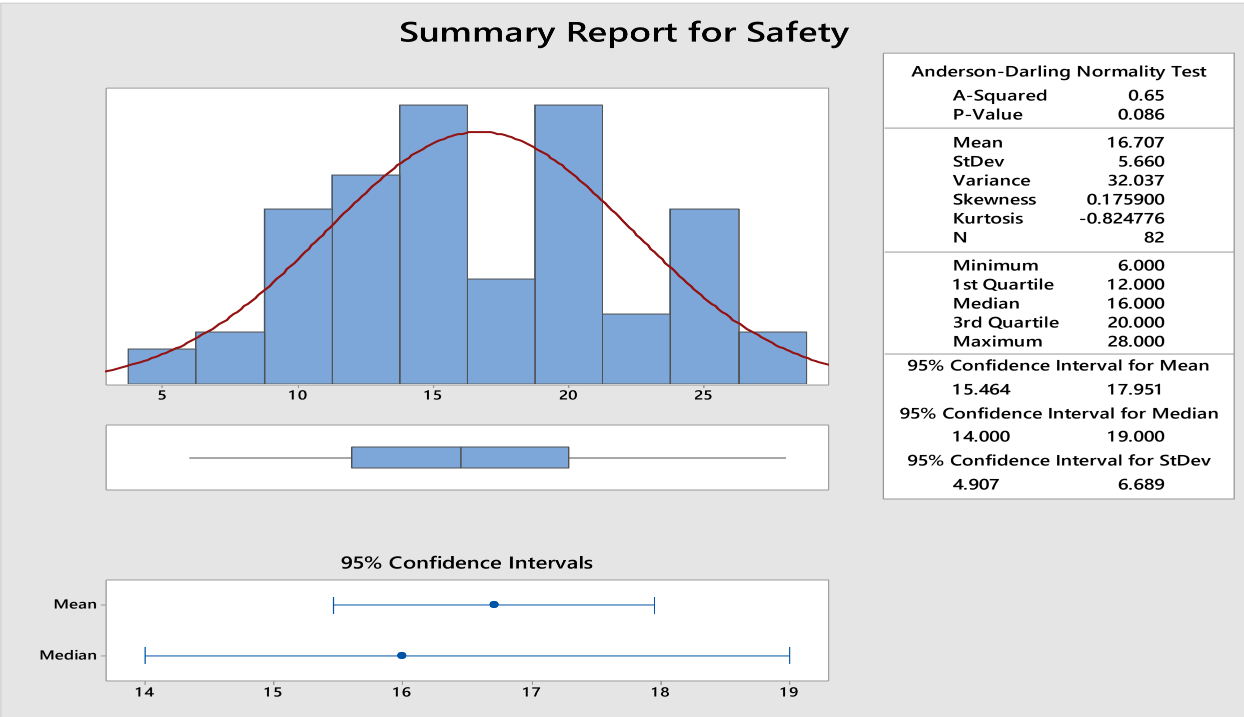

Fig. 3: SAS Print Out of Statistic Summary Report of Safety

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d)

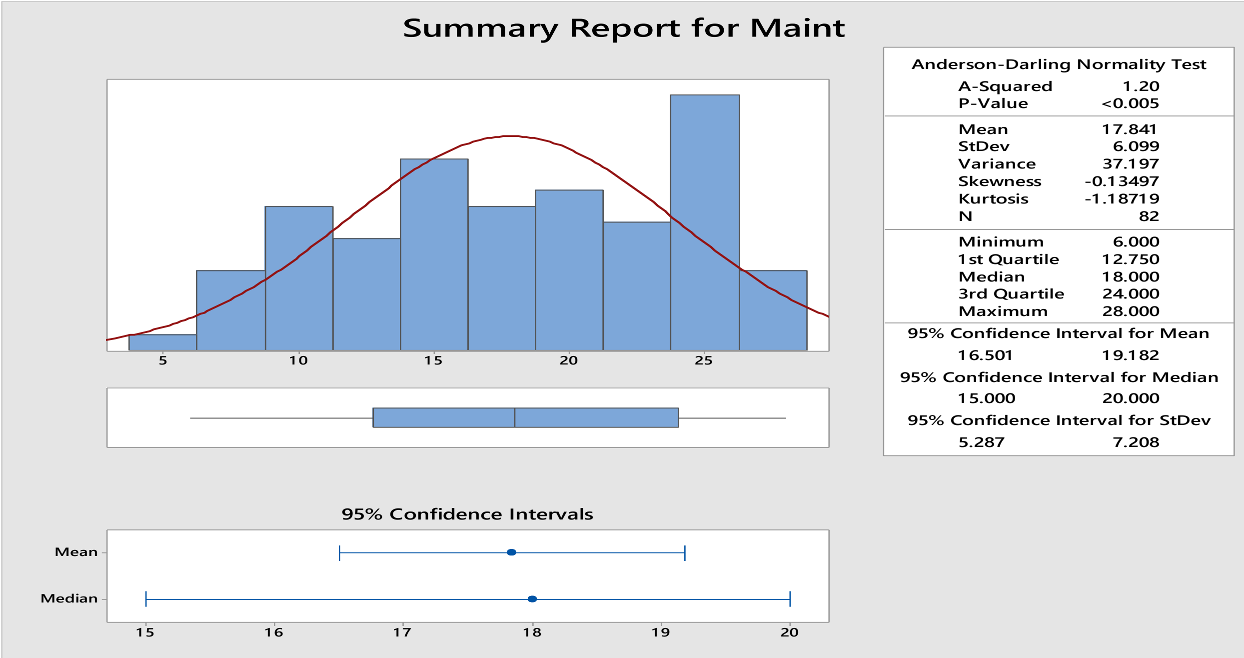

Fig. 4: SAS Print Out of Statistic Summary Report of Maintenance

e)

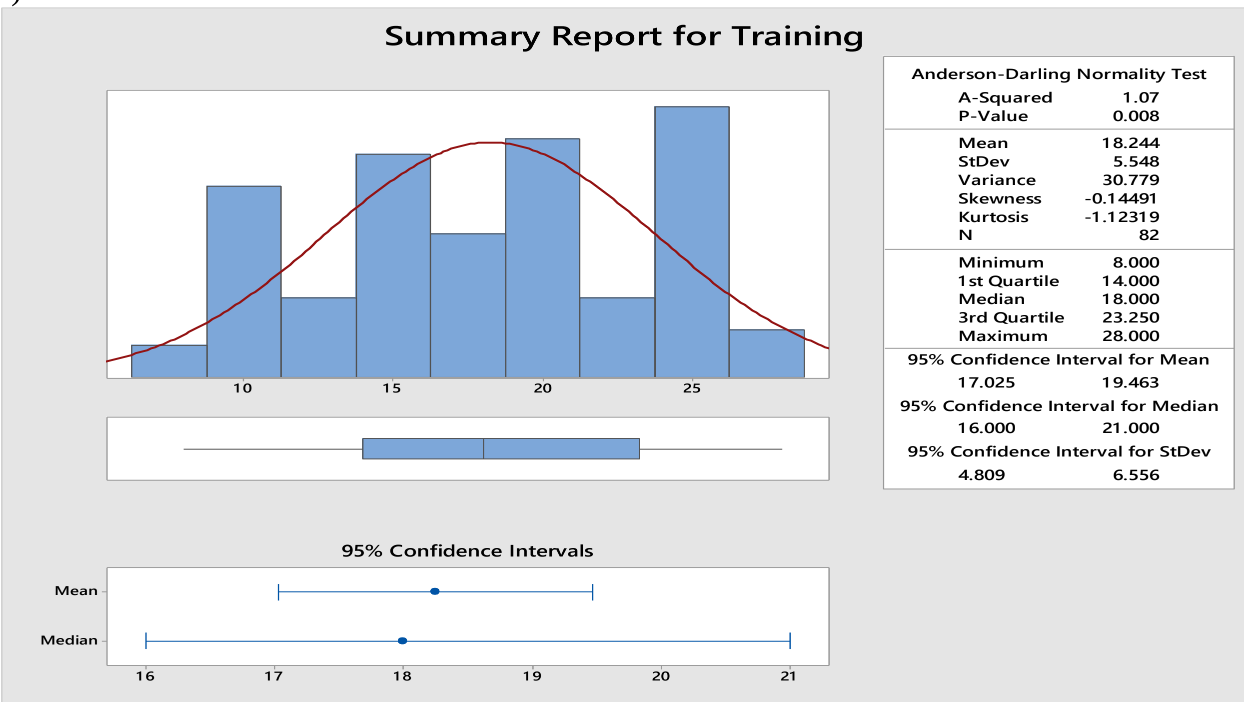

Fig. 5: SAS Print Out of Statistic Summary Report of Training

f)

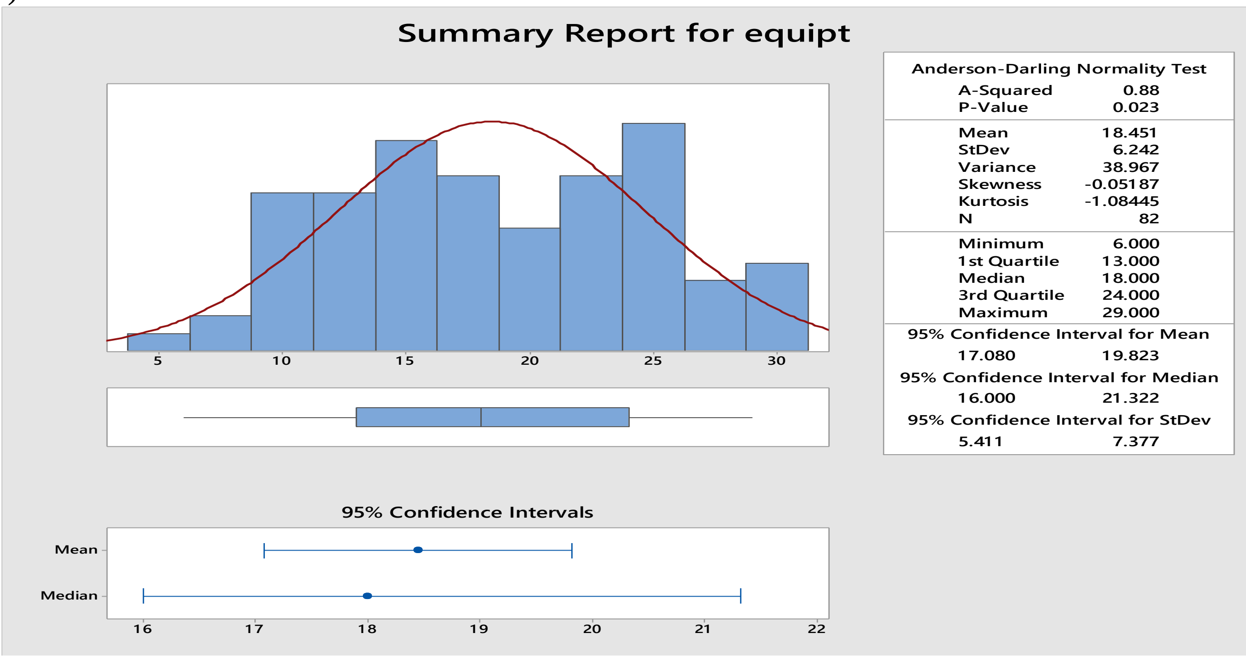

Fig. 6: SAS Print Out of Statistic Summary Report of Equipment

g)

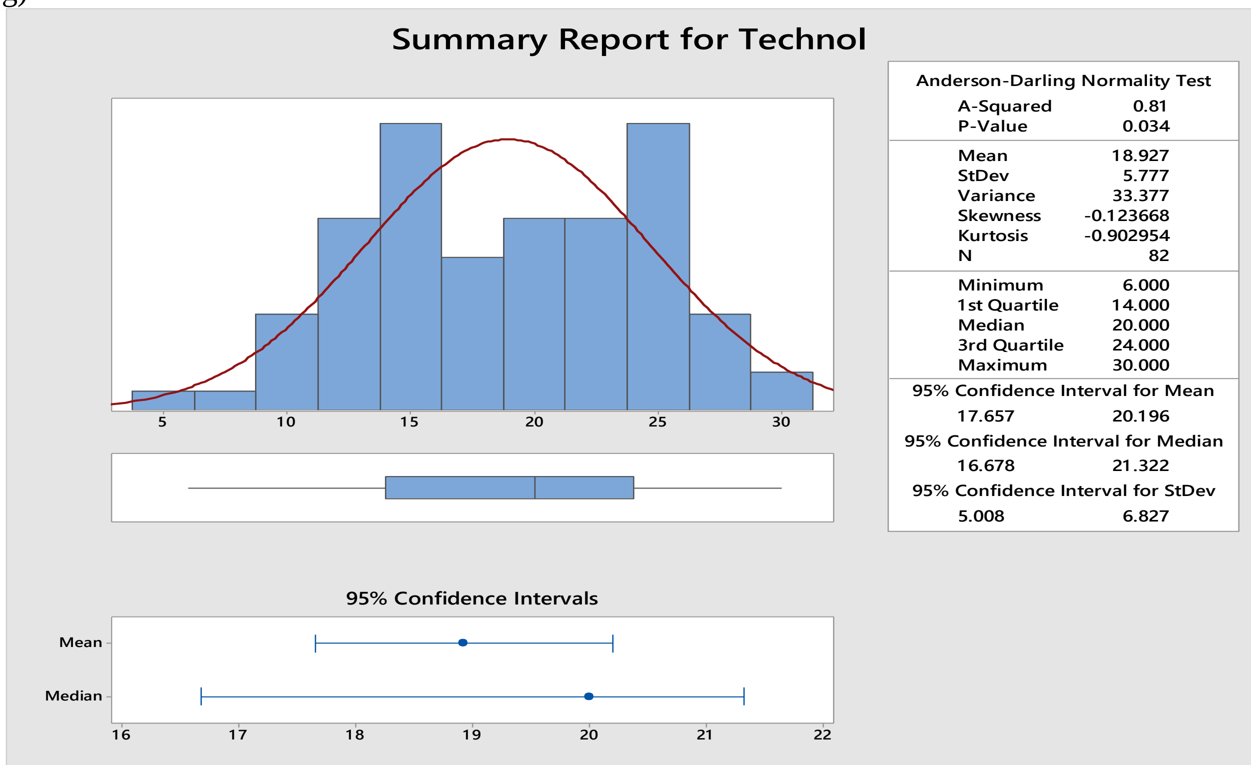

Fig. 7: SAS Print Out of Statistic Summary Report of Technology

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h)

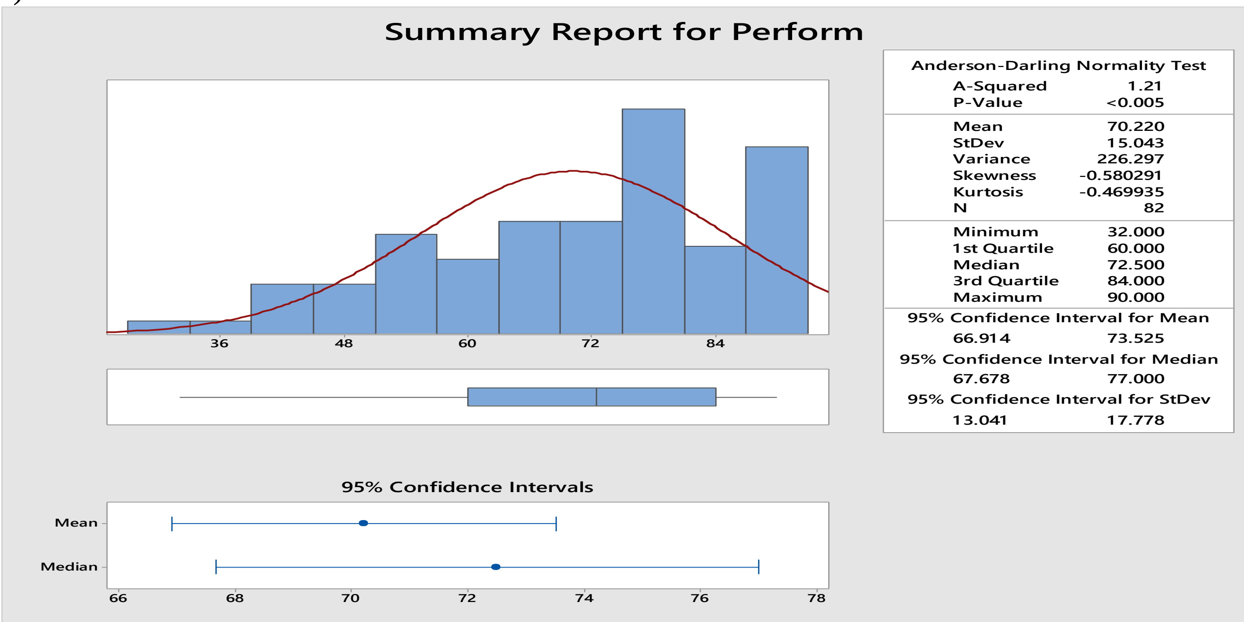
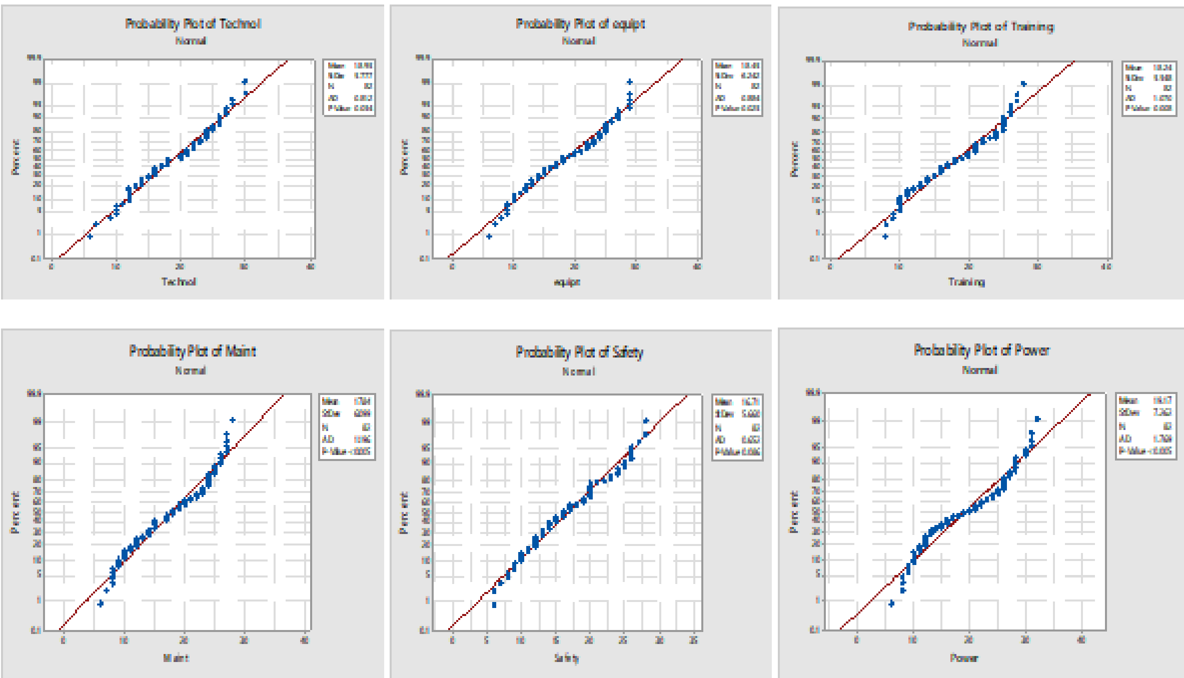


Fig. 8: SAS Print Out of Statistic Summary Report of Performance Values.

Test for Normality- Anderson -Darling



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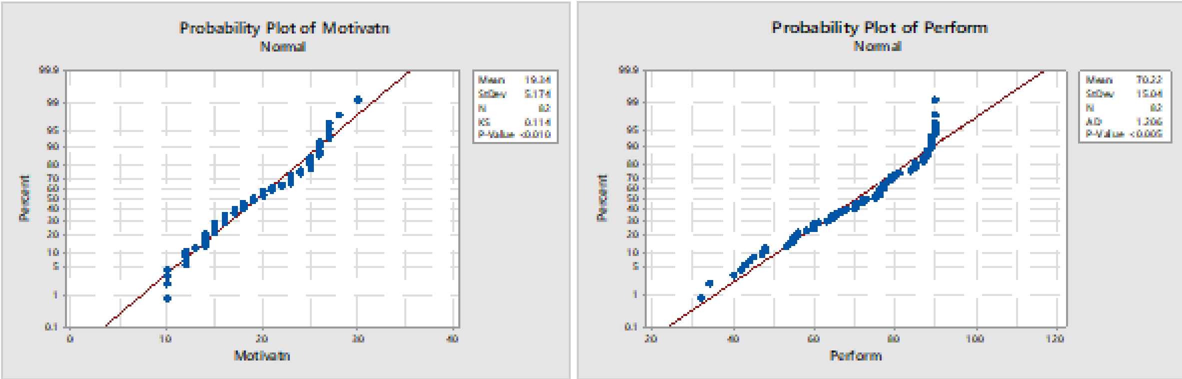

Fig. 9: Response Curve of Test for Normality (Anderson –Darling)

These graphs test whether the various group of data follow normal distribution for continuous measurements, which they proved positive.

Polynomial Regression Analyses

Polynomial Regression Analyses and Curve Estimations of the Factors in the three case study industries are shown as follows:

The regression equation is

Perform = - 19.28 + 7.149 Motivatn - 0.1406 Motivatn^2 + 0.000862 Motivatn^3 5

S = 4.92085 R-Sq = 89.7% R-Sq(adj) = 89.3%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	16441.3	5480.43	226.33	0.000
Error	78	1888.8	24.21		
Total	81	18330.0			

Sequential Analysis of Variance

Source	DF	SS	F	P
Linear	1	16008.7	551.71	0.000
Quadratic	1	431.3	18.03	0.000
Cubic	1	1.3	0.05	0.821

Figure 10: SAS Print Out of Polynomial Regression Analysis: Performance versus Motivation

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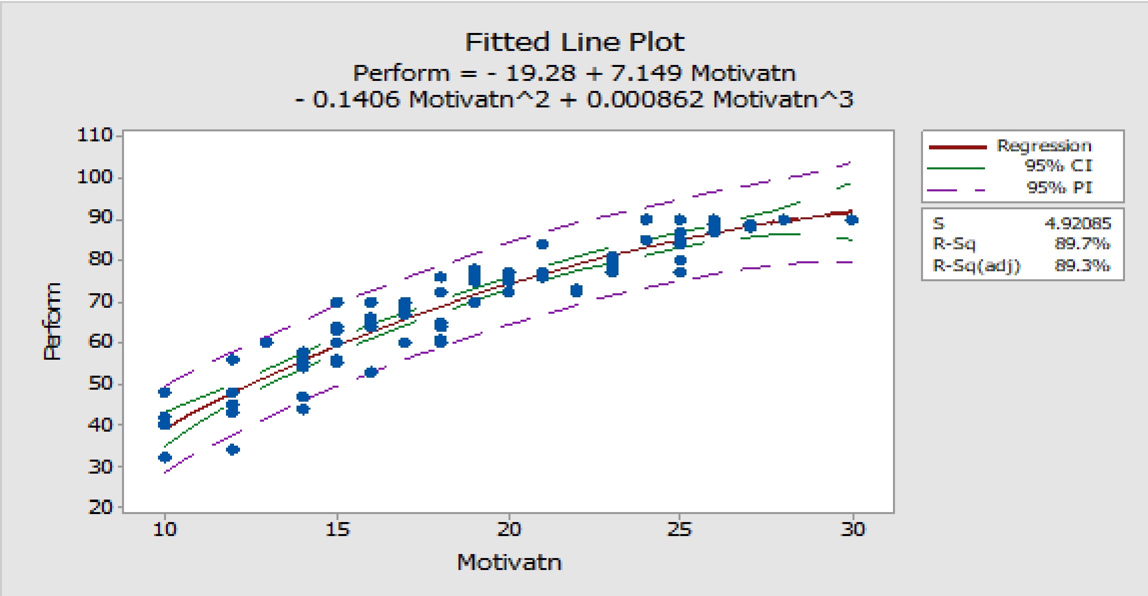

Figure 11: Response Curve for Polynomial Regression of Performance versus Motivation

The regression equation is

Perform = 210.2 - 24.96 Power + 1.245 Power^2 - 0.01833 Power^3 6

S = 9.31412 R-Sq = 63.1% R-Sq(adj) = 61.7%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	11563.3	3854.44	44.43	0.000
Error	78	6766.7	86.75		
Total	81	18330.0			

Sequential Analysis of Variance

Source	DF	SS	F	P
Linear	1	4062.86	22.78	0.000
Quadratic	1	4880.10	41.07	0.000
Cubic	1	2620.37	30.21	0.000

Figure 12: SAS Print Out of Polynomial Regression Analysis: Performance versus Power

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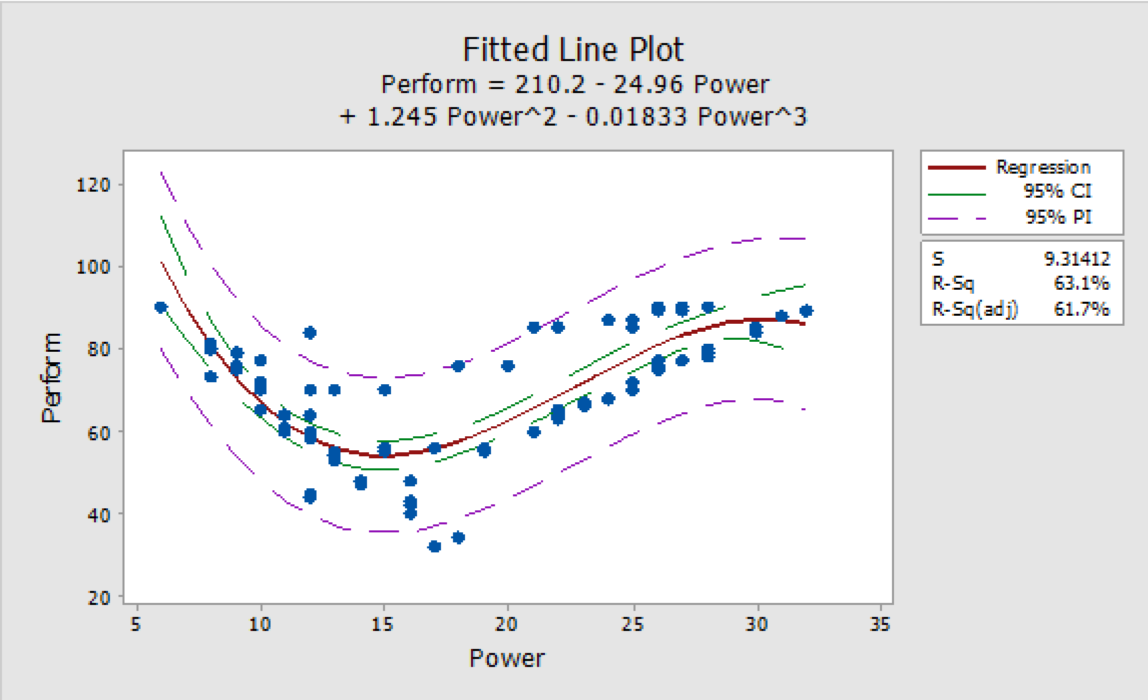

Figure 13: Response Curve for Polynomial Regression of Performance versus Power

The regression equation is

Perform = 169.3 - 19.67 Safety + 1.083 Safety^2 - 0.01705 Safety^3 7

S = 10.6217 R-Sq = 52.0% R-Sq(adj) = 50.1%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	9530.0	3176.67	28.16	0.000
Error	78	8800.0	112.82		
Total	81	18330.0			

Sequential Analysis of Variance

Source	DF	SS	F	P
Linear	1	4408.42	25.33	0.000
Quadratic	1	4167.42	33.75	0.000
Cubic	1	954.17	8.46	0.005

Figure 14: SAS Print Out of Polynomial Regression Analysis: Performance versus Safety

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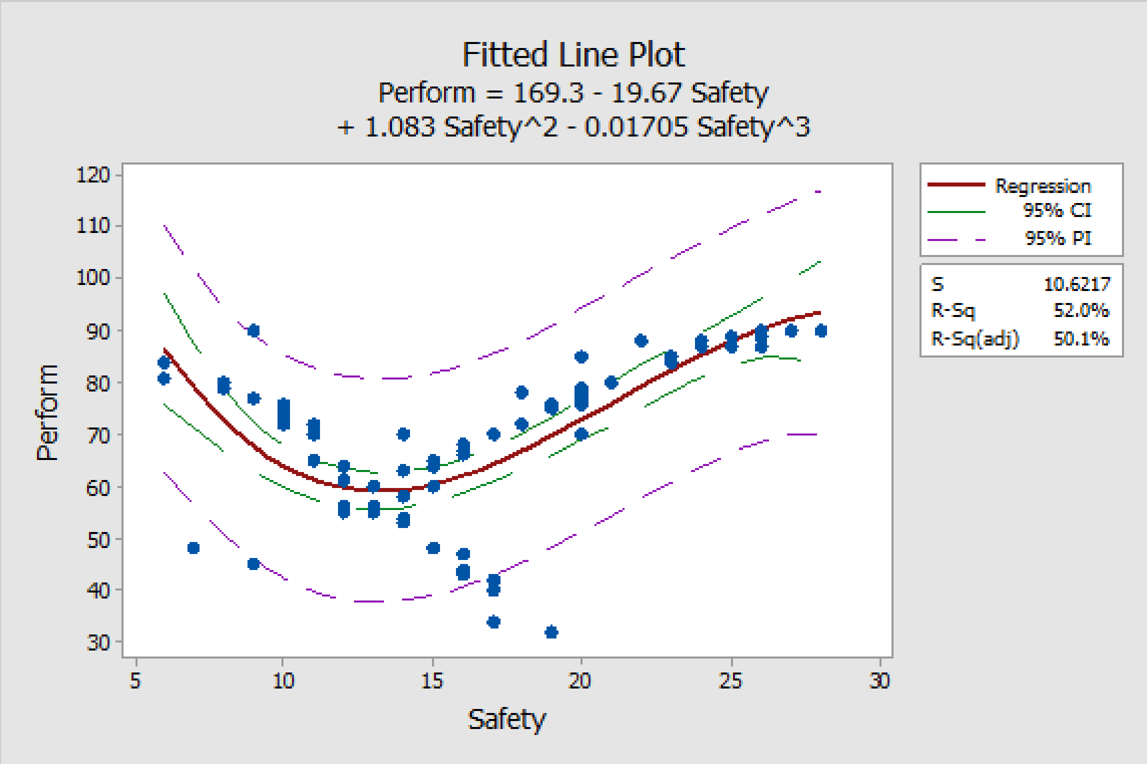

Figure 15: Response Curve for Polynomial Regression of Performance versus Safety

The regression equation is

Perform = 181.3 - 19.85 Maint + 0.9643 Maint^2 - 0.01304 Maint^3 8

S = 9.55564 R-Sq = 61.1% R-Sq(adj) = 59.7%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	11207.9	3735.95	40.91	0.000
Error	78	7122.2	91.31		
Total	81	18330.0			

Sequential Analysis of Variance

Source	DF	SS	F	P
Linear	1	3189.28	16.85	0.000
Quadratic	1	7547.76	78.53	0.000
Cubic	1	470.81	5.16	0.026

Figure 16: SAS Print Out of Polynomial Regression Analysis: Performance versus Maintenance

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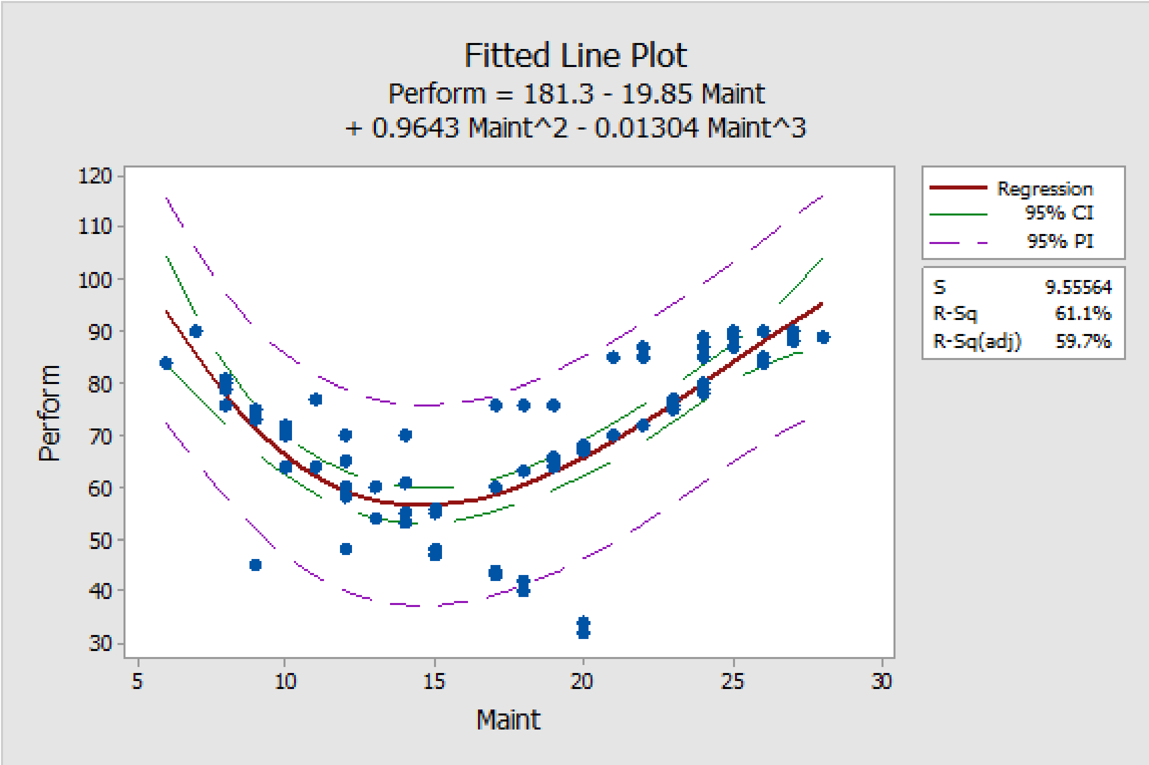

Figure 17: Response Curve for Polynomial Regression of Performance versus Maintenance

The regression equation is

Perform = 10.44 + 4.168 training - 0.04478 training^2 9

S = 4.69658 R-Sq = 90.5% R-Sq(adj) = 90.3%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	2	16587.5	8293.74	376.00	0.000
Error	79	1742.6	22.06		
Total	81	18330.0			

Sequential Analysis of Variance

Source	DF	SS	F	P
Linear	1	16458.0	703.32	0.000
Quadratic	1	129.5	5.87	0.018

Figure 18: SAS Print Out of Polynomial Regression Analysis: Performance versus Training

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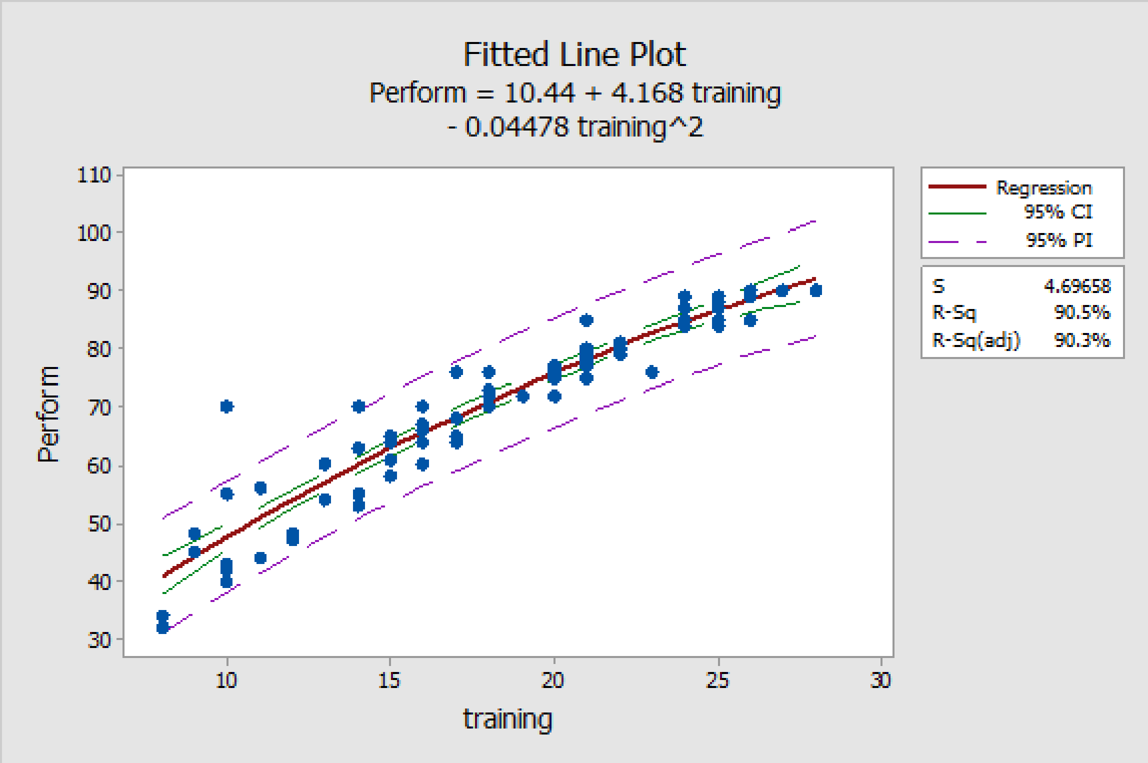

Figure 19: Response Curve for Polynomial Regression of Performance versus Training

The regression equation is

Perform = 3.50 + 5.779 equipt - 0.1320 equipt^2 + 0.001202 equipt^3 10

S = 4.96705 R-Sq = 89.5% R-Sq(adj) = 89.1%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	16405.7	5468.56	221.65	0.000
Error	78	1924.4	24.67		
Total	81	18330.0			

Sequential Analysis of Variance

Source	DF	SS	F	P
Linear	1	15912.2	526.50	0.000
Quadratic	1	486.7	19.91	0.000
Cubic	1	6.7	0.27	0.604

Figure 20: SAS Print Out of Polynomial Regression Analysis: Performance versus Equipment

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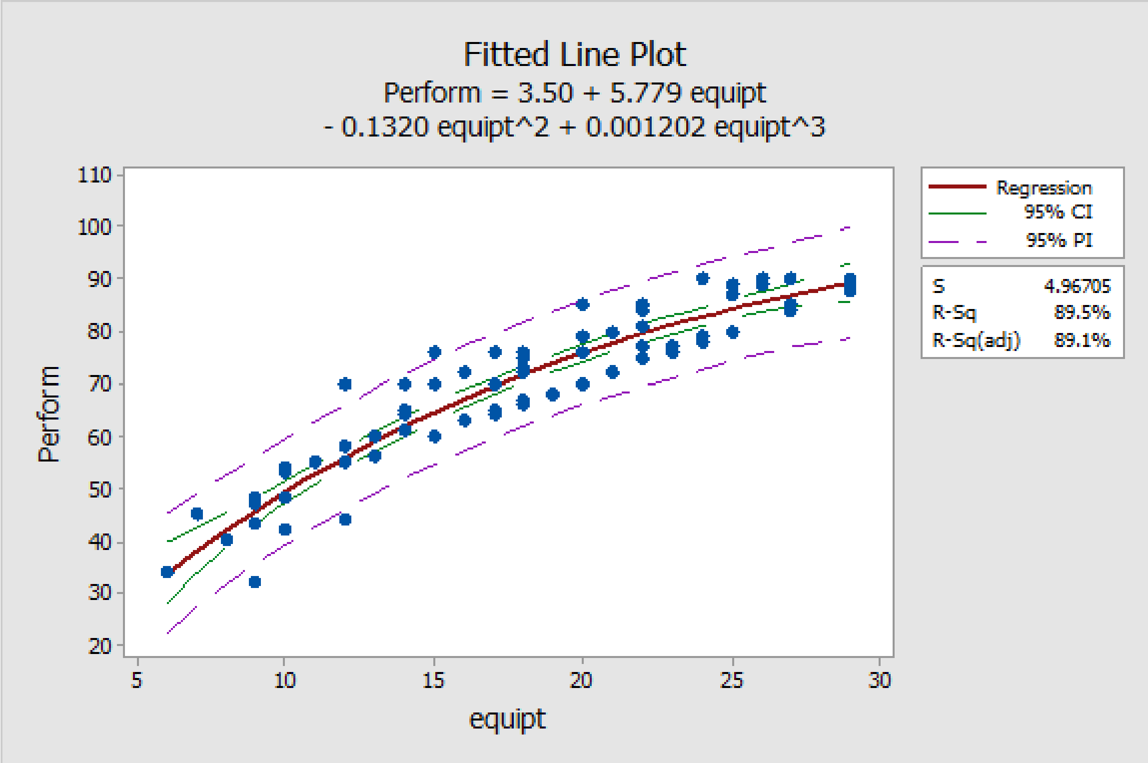

Figure 21: Response Curve for Polynomial Regression of Performance versus Equipment

The regression equation is

Perform = 65.04 - 4.568 Technol + 0.3814 Technol^2 - 0.006671 Technol^3 11

S = 7.60794 R-Sq = 75.4% R-Sq(adj) = 74.4%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	13815.4	4605.12	79.56	0.000
Error	78	4514.7	57.88		
Total	81	18330.0			

Sequential Analysis of Variance

Source	DF	SS	F	P
Linear	1	13580.4	228.74	0.000
Quadratic	1	19.8	0.33	0.567
Cubic	1	215.2	3.72	0.057

Figure 22: SAS Print Out of Polynomial Regression Analysis: Performance versus Technology

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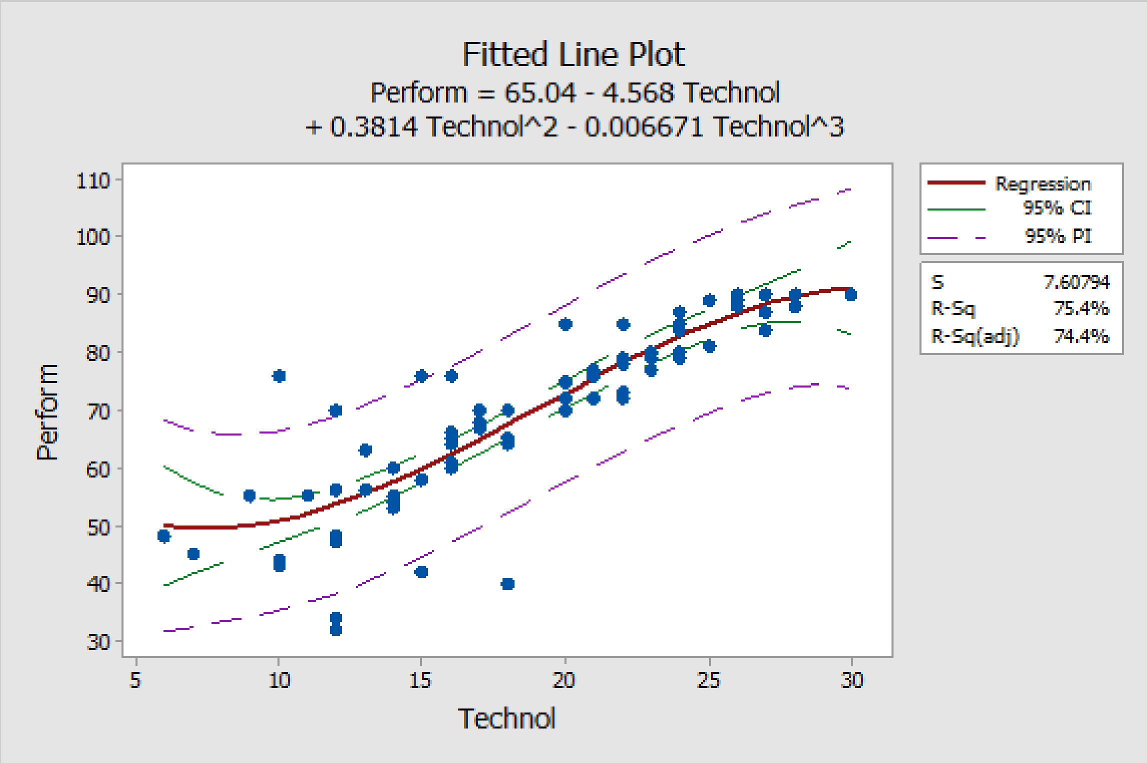


Figure 23: Response Curve for Polynomial Regression of Performance versus Technology

Response Surface Method (RSM) for predicting Performance of the Manufacturing Workers more accurately Since the linear model developed would not be able to predict the performance accurately, hence the application of the Response Surface Regression technique with the introduction of shape factor.

Response Surface Regression of Performance versus Motivation, Power, Safety, Maintenance, Training, Equipment and Technology

The response surface regression technique is employed in studying some phenomena that are not possible with the SPSS and is also used to identify if there is any difference or improvement in the performance. The technique is also used to validate the performance of workers. Equations were printed out fewer than 3 significance levels. Therefore, response surface regression generated values from Minitab-17 software through field generated data are presented as follows.

Stepwise Selection of Terms

α to enter = 0.05, α to remove = 0.05

The stepwise procedure added terms during the procedure in order to maintain a hierarchical model at each step.

Print ISSN: ISSN 2055-6551(Print), Online ISSN: ISSN 2055-656X(Onlin

Table 1: Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	10	17736.8	1773.68	212.28	0.000
Linear	7	12383.7	1769.09	211.74	0.000
motivatn	1	130.5	130.53	15.62	0.000
Power	1	64.7	64.66	7.74	0.007
Safety	1	70.4	70.40	8.43	0.005
maint	1	136.6	136.60	16.35	0.000
training	1	51.1	51.08	6.11	0.016
equipt	1	174.7	174.74	20.91	0.000
Technol	1	3.1	3.08	0.37	0.546
Square	1	178.6	178.56	21.37	0.000
equipt*equipt	1	178.6	178.56	21.37	0.000
2-Way Interaction	2	147.0	73.52	8.80	0.000
Power*Technol	1	51.6	51.56	6.17	0.015
maint*training	1	141.6	141.56	16.94	0.000
Error	71	593.2	8.36		
Total	81	18330.0			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
2.89054	96.76%	96.31%	95.13%

Table 2 Coded Coefficients

Term	Effect	Coef	SE Coef	T-Value	P-Value	VIF
Constant		72.387	0.670	108.00	0.000	
motivatn	17.43	8.72	2.21	3.95	0.000	12.62
Power	13.22	6.61	2.38	2.78	0.007	17.09
Safety	12.72	6.36	2.19	2.90	0.005	12.31
maint	-24.93	-12.46	3.08	-4.04	0.000	28.32
training	11.70	5.85	2.37	2.47	0.016	16.71
equipt	26.16	13.08	2.86	4.57	0.000	23.37
Technol	-2.44	-1.22	2.01	-0.61	0.546	9.10
equipt*equipt	-15.84	-7.92	1.71	-4.62	0.000	2.37

Print ISSN: ISSN 2055-6551(Print), Online ISSN: ISSN 2055-656X(Onlin

Power*Technol	-16.85	-8.42	3.39	-2.48	0.015	8.17
maint*training	22.50	11.25	2.73	4.12	0.000	6.19

Regression Equation in Uncoded Units

The following equations (12, 13 and 14) give the response surface regression model generated from the data

Perform = 20.61 + 0.872 motivatn + 1.481 Power + 0.578 Safety - 2.974 maint - 1.154 training + 3.234 equipt + 0.924 Technol - 0.0599 equipt*equipt - 0.0540 Power*Technol + 0.1023 maint*training **12**

Fits and Diagnostics for Unusual Observations

Obs	Perform	Fit	Resid	Std Resid	
5	76.00	75.36	0.64	0.31	X
7	85.00	78.48	6.52	2.50	R
10	70.00	57.31	12.69	4.99	R
14	76.00	68.27	7.73	2.81	R
71	90.00	89.76	0.24	0.11	X
73	32.00	37.46	-5.46	-2.16	R
81	84.00	81.90	2.10	0.96	

Response Surface Regression: Perform versus motivatn, Power, Safety, maint, training

Stepwise Selection of Terms

α to enter = 0.1, α to remove = 0.1

The stepwise procedure added terms during the procedure in order to maintain a hierarchical model at each step.

Table 3 Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	10	17736.8	1773.68	212.28	0.000
Linear	7	12383.7	1769.09	211.74	0.000
motivatn	1	130.5	130.53	15.62	0.000
Power	1	64.7	64.66	7.74	0.007
Safety	1	70.4	70.40	8.43	0.005
maint	1	136.6	136.60	16.35	0.000
training	1	51.1	51.08	6.11	0.016
equipt	1	174.7	174.74	20.91	0.000

Print ISSN: ISSN 2055-6551(Print), Online ISSN: ISSN 2055-656X(Onlin

Technol	1	3.1	3.08	0.37	0.546
Square	1	178.6	178.56	21.37	0.000
equipt*equipt	1	178.6	178.56	21.37	0.000
2-Way Interaction	2	147.0	73.52	8.80	0.000
Power*Technol	1	51.6	51.56	6.17	0.015
maint*training	1	141.6	141.56	16.94	0.000
Error	71	593.2	8.36		
Total	81	18330.0			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
2.89054	96.76%	96.31%	95.13%

Table 4 Coded Coefficients

Term	Effect	Coef	SE Coef	T-Value	P-Value	VIF
Constant		72.387	0.670	108.00	0.000	
motivatn	17.43	8.72	2.21	3.95	0.000	12.62
Power	13.22	6.61	2.38	2.78	0.007	17.09
Safety	12.72	6.36	2.19	2.90	0.005	12.31
maint	-24.93	-12.46	3.08	-4.04	0.000	28.32
training	11.70	5.85	2.37	2.47	0.016	16.71
equipt	26.16	13.08	2.86	4.57	0.000	23.37
Technol	-2.44	-1.22	2.01	-0.61	0.546	9.10
equipt*equipt	-15.84	-7.92	1.71	-4.62	0.000	2.37
Power*Technol	-16.85	-8.42	3.39	-2.48	0.015	8.17
maint*training	22.50	11.25	2.73	4.12	0.000	6.19

Regression Equation in Uncoded Units

Perform = 20.61 + 0.872 motivatn + 1.481 Power + 0.578 Safety - 2.974 maint - 1.154 training + 3.234 equipt + 0.924 Technol - 0.0599 equipt*equipt - 0.0540 Power*Technol + 0.1023 maint*training **13**

Fits and Diagnostics for Unusual Observations

Obs	Perform	Fit	Resid	Std Resid	
5	76.00	75.36	0.64	0.31	X
7	85.00	78.48	6.52	2.50	R
10	70.00	57.31	12.69	4.99	R
14	76.00	68.27	7.73	2.81	R

Print ISSN: ISSN 2055-6551(Print), Online ISSN: ISSN 2055-656X(Onlin

71	90.00	89.76	0.24	0.11	X
73	32.00	37.46	-5.46	-2.16	R
81	84.00	81.90	2.10	0.96	X

R Large residual

Response Surface Regression: Perform versus motivation, Power, Safety, maintenance, training, Equipment and Technology

Stepwise Selection of Terms α to enter = 0.15, α to remove = 0.15

The stepwise procedure added terms during the procedure in order to maintain a hierarchical model at each step.

Table 5 Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	18	17976.3	998.681	177.84	0.000
Linear	7	6475.6	925.089	164.73	0.000
motivatn	1	16.0	15.985	2.85	0.097
Power	1	7.7	7.731	1.38	0.245
Safety	1	93.5	93.488	16.65	0.000
maint	1	37.6	37.639	6.70	0.012
training	1	57.6	57.563	10.25	0.002
equipt	1	119.5	119.494	21.28	0.000
Technol	1	1.9	1.903	0.34	0.563
Square	1	110.9	110.924	19.75	0.000
Technol*Technol	1	110.9	110.924	19.75	0.000
2-Way Interaction	10	492.7	49.269	8.77	0.000
motivatn*Power	1	58.4	58.448	10.41	0.002
motivatn*maint	1	119.6	119.617	21.30	0.000
motivatn*equipt	1	53.4	53.435	9.52	0.003
Power*training	1	101.4	101.430	18.06	0.000
Power*Technol	1	41.9	41.933	7.47	0.008
Safety*Technol	1	76.3	76.270	13.58	0.000
maint*training	1	84.2	84.200	14.99	0.000
maint*Technol	1	40.0	39.996	7.12	0.010
training*equipt	1	14.7	14.670	2.61	0.111
equipt*Technol	1	41.8	41.844	7.45	0.008
Error	63	353.8	5.616		
Total	81	18330.0			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
2.36973	98.07%	97.52%	95.74%

Table 6 Coded Coefficients

Term	Effect	Coef	SE Coef	T-Value	P-Value	VIF
Constant		71.317	0.648	110.14	0.000	
motivatn	8.07	4.04	2.39	1.69	0.097	22.10
Power	5.15	2.57	2.19	1.17	0.245	21.68
Safety	15.56	7.78	1.91	4.08	0.000	13.89
maint	-15.14	-7.57	2.92	-2.59	0.012	37.90
training	18.14	9.07	2.83	3.20	0.002	35.63
equipt	24.26	12.13	2.63	4.61	0.000	29.38
Technol	-3.30	-1.65	2.83	-0.58	0.563	26.81
Technol*Technol	34.86	17.43	3.92	4.44	0.000	13.01
motivatn*Power	-83.0	-41.5	12.9	-3.23	0.002	146.74
motivatn*maint	114.6	57.3	12.4	4.62	0.000	156.75
motivatn*equipt	-28.71	-14.35	4.65	-3.08	0.003	18.88
Power*training	106.4	53.2	12.5	4.25	0.000	146.75
Power*Technol	-72.3	-36.2	13.2	-2.73	0.008	185.21
Safety*Technol	-25.76	-12.88	3.50	-3.69	0.000	16.06
maint*training	-100.1	-50.0	12.9	-3.87	0.000	205.96
maint*Technol	64.0	32.0	12.0	2.67	0.010	185.15
training*equipt	16.39	8.19	5.07	1.62	0.111	25.63
equipt*Technol	-36.63	-18.32	6.71	-2.73	0.008	35.76

Regression Equation in Uncoded Units

Perform = 24.42 - 0.196 motivatn + 3.396 Power + 2.464 Safety - 7.28 maint - 0.379 training + 4.658 equipt - 0.230 Technol + 0.1210 Technol*Technol - 0.3194 motivatn*Power + 0.521 motivatn*maint - 0.1248 motivatn*equipt + 0.4091 Power*training - 0.2319 Power*Technol - 0.0976 Safety*Technol - 0.455 maint*training + 0.2425 maint*Technol + 0.0712 training*equipt - 0.1327 equipt*Technol 14

Fits and Diagnostics for Unusual Observations

Obs	Perform	Fit	Resid	Std Resid	
5	76.00	74.79	1.21	1.05	X
10	70.00	64.99	5.01	3.36	R
14	76.00	68.24	7.76	3.57	R

Print ISSN: ISSN 2055-6551(Print), Online ISSN: ISSN 2055-656X(Onlin

31 56.00 51.06 4.94 2.25 R

74 44.00 49.15 -5.15 -3.02 R

R Large residual

X Unusual X

Prediction for Performance

The predictions of the performance from the equations generated are from the multi linear regression equations and response surface regression equations are shown as follows.

Prediction for Performance: Regression Equation in Uncoded Units, Multi – linear Regression, α = 0.05

Perform = 26.07 + 0.877 motivatn + 0.480 Power + 0.614 Safety - 1.356 maint + 0.789 training + 1.421 equipt - 0.459 Technol

15

Variable	Setting
motivatn	25
Power	21
Safety	20
maint	22
training	26
equipt	22
Technol	24

Fit	SE Fit	95% CI	95% PI
81.2773	1.53375	(78.2213, 84.3334)	(73.5287, 89.0259)

Figure 24: SAS print out of Prediction for Performance in Multi – linear Regression Equation

Prediction for Perform Multi- linear Regression,

α = 0.15

Regression Equation in Uncoded Units

Perform = 26.07 + 0.877 motivatn + 0.480 Power + 0.614 Safety - 1.356 maint + 0.789 training + 1.421 equipt - 0.459 Technol

15

Variable	Setting
motivatn	25

Print ISSN: ISSN 2055-6551(Print), Online ISSN: ISSN 2055-656X(Onlin

Power 21

Safety 20

maint 22

training 26

equipt 22

Technol 24

Fit	SE Fit	95% CI	95% PI
81.2773	1.53375	(78.2213, 84.3334)	(73.5287, 89.0259)

Figure 25: SAS print out of Prediction for Performance in Multi – linear Regression Equation

Prediction for Performance of Quadratic Shape Regression Equations

The following SAS print out show the predictions in the performance of the response surface regression equations in quadratic shapes generated as in the models of 4.7and 4.8 or 4.9.

Regression Equation in Uncoded Units:

Full quadratic, α = 0.05

Perform = 20.61 + 0.872 motivatn + 1.481 Power + 0.578 Safety - 2.974 maint - 1.154 training + 3.234 equipt + 0.924 Technol - 0.0599 equipt*equipt - 0.0540 Power*Technol + 0.1023 maint*training

16

Variable Setting

motivatn 25

Power 21

Safety 20

maint 22

training 26

equipt 22

Technol 24

Fit	SE Fit	95% CI	95% PI
85.2507	1.40485	(82.4496, 88.0519)	(78.8425, 91.6590)

Print ISSN: ISSN 2055-6551(Print), Online ISSN: ISSN 2055-656X(Onlin

Figure 26: SAS print out for Prediction of Performance at Full quadratic, α = 0.05

Regression Equation in Uncoded Units:

Full quadratic, α = 0.10

Perform = 20.61 + 0.872 motivatn + 1.481 Power + 0.578 Safety - 2.974 maint - 1.154 training + 3.234 equipt + 0.924 Technol - 0.0599 equipt*equipt - 0.0540 Power*Technol + 0.1023 maint*training

17

Variable	Setting
motivatn	25
Power	21
Safety	20
maint	22
training	26
equipt	22
Technol	24

Fit	SE Fit	95% CI	95% PI
85.2507	1.40485	(82.4496, 88.0519)	(78.8425, 91.6590)

Figure 27: SAS print out of Prediction of Performance at Full quadratic, α = 0.10

Regression Equation in Uncoded Units:

Full quadratic, α = 0.15

Perform = 24.42 - 0.196 motivatn + 3.396 Power + 2.464 Safety - 7.28 maint - 0.379 training + 4.658 equipt - 0.230 Technol + 0.1210 Technol*Technol - 0.3194 motivatn*Power + 0.521 motivatn*maint - 0.1248 motivatn*equipt + 0.4091 Power*training - 0.2319 Power*Technol - 0.0976 Safety*Technol - 0.455 maint*training + 0.2425 maint*Technol + 0.0712 training*equipt - 0.1327 equipt*Technol 18

Print ISSN: ISSN 2055-6551(Print), Online ISSN: ISSN 2055-656X(Onlin

Variable Setting

motivatn 25

Power 21

Safety 20

maint 22

training 26

equipt 22

Technol 24

Fit	SE Fit	95% CI	95% PI
85.0281	1.27389	(82.4824, 87.5738)	(79.6517, 90.4045)

Figure 28: SAS print out of Prediction of Performance at Full quadratic, α = 0.15

Response Surface Regression Plots

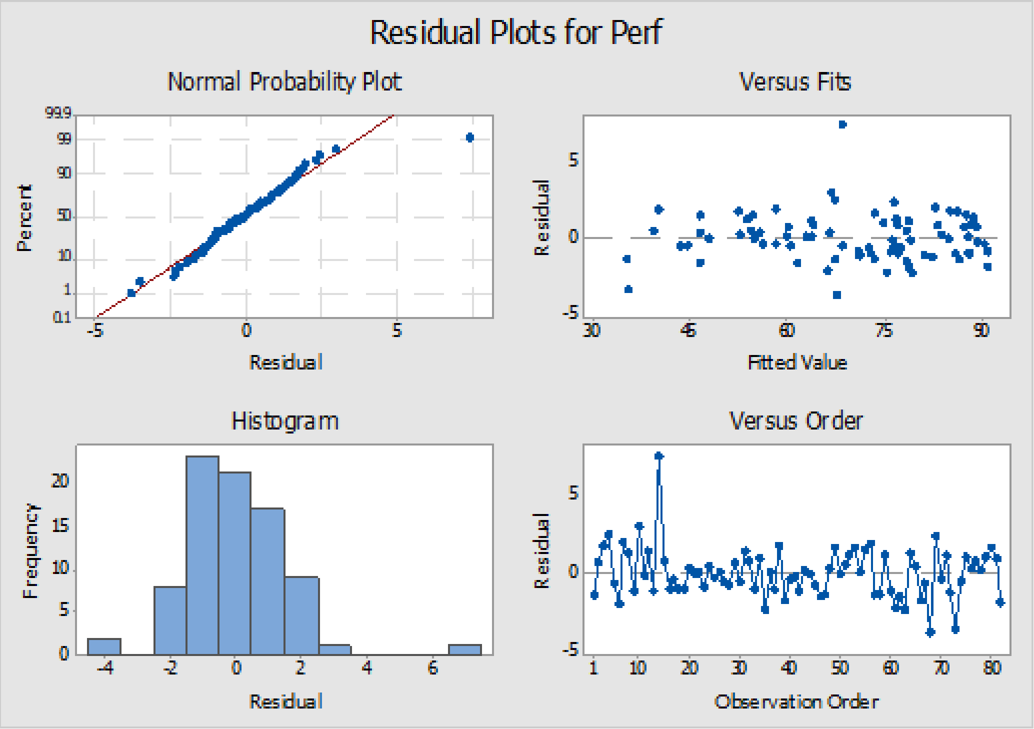


Figure 29: Response Plots of Residual for Performance

Print ISSN: ISSN 2055-6551(Print), Online ISSN: ISSN 2055-656X(Onlin

Figure 30: Response Main Effects Plot for Performance

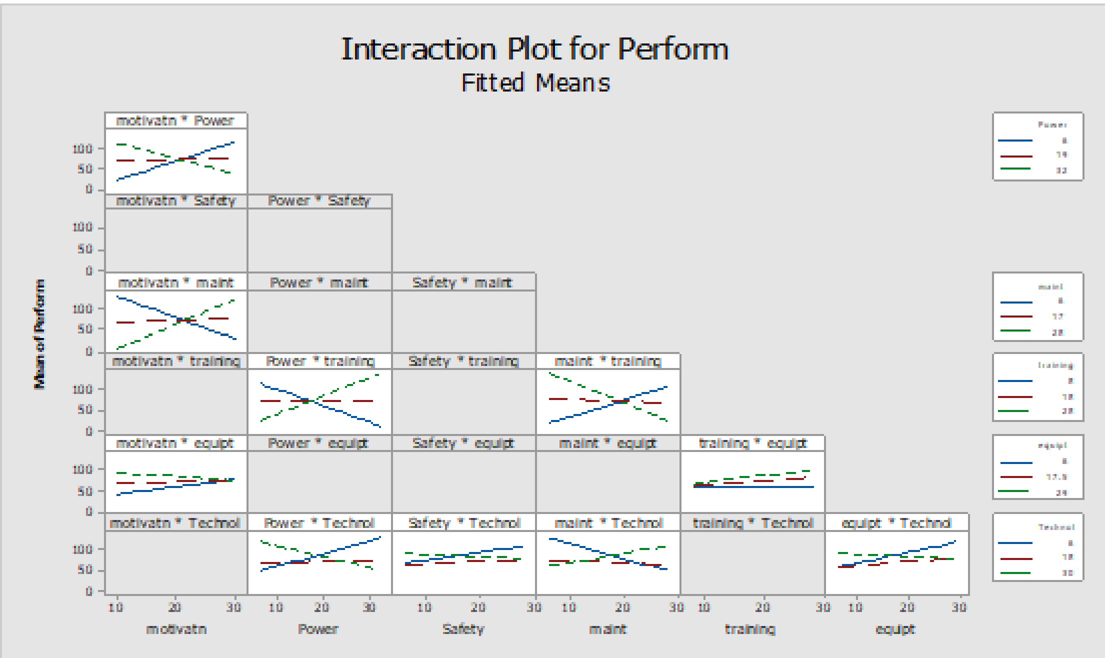


Figure 31: Response Plot of Interaction of factors with Performance

Print ISSN: ISSN 2055-6551(Print), Online ISSN: ISSN 2055-656X(Onlin

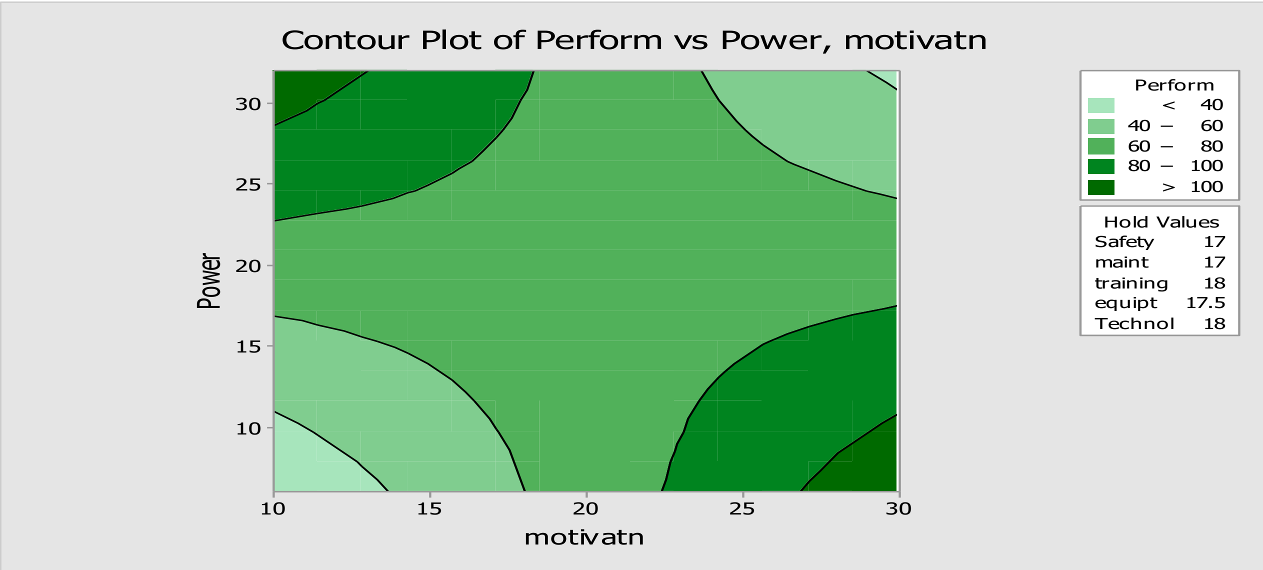
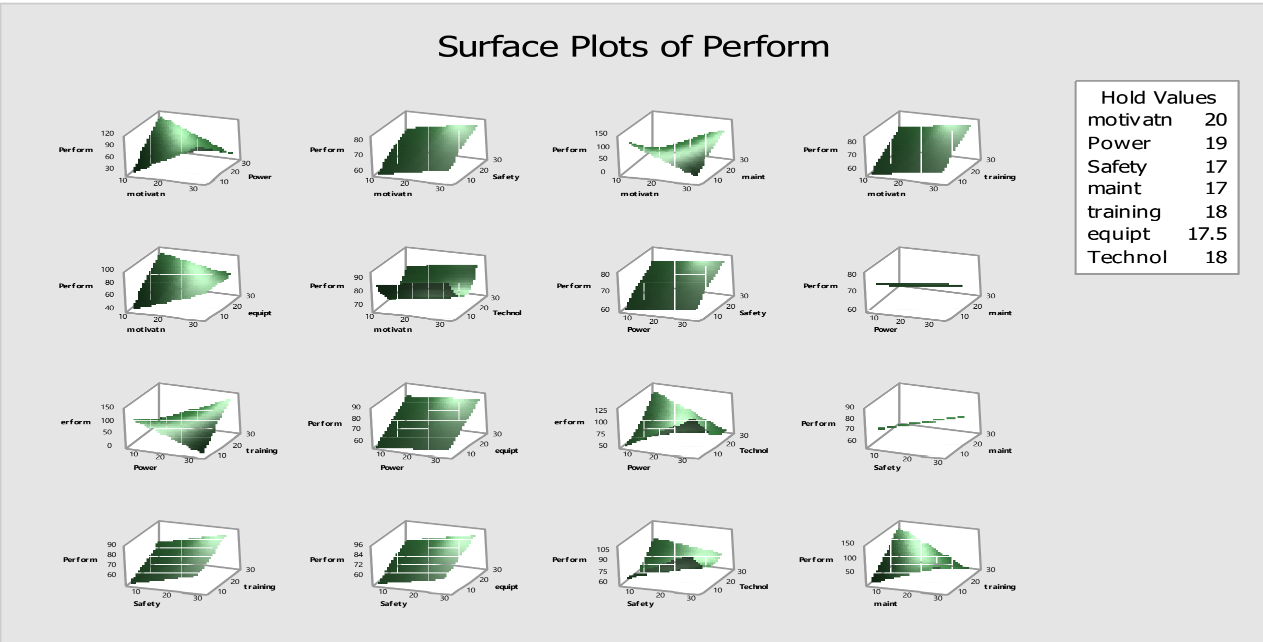


Figure 33: Response Contour Plot for Performance Vs Power and Motivation



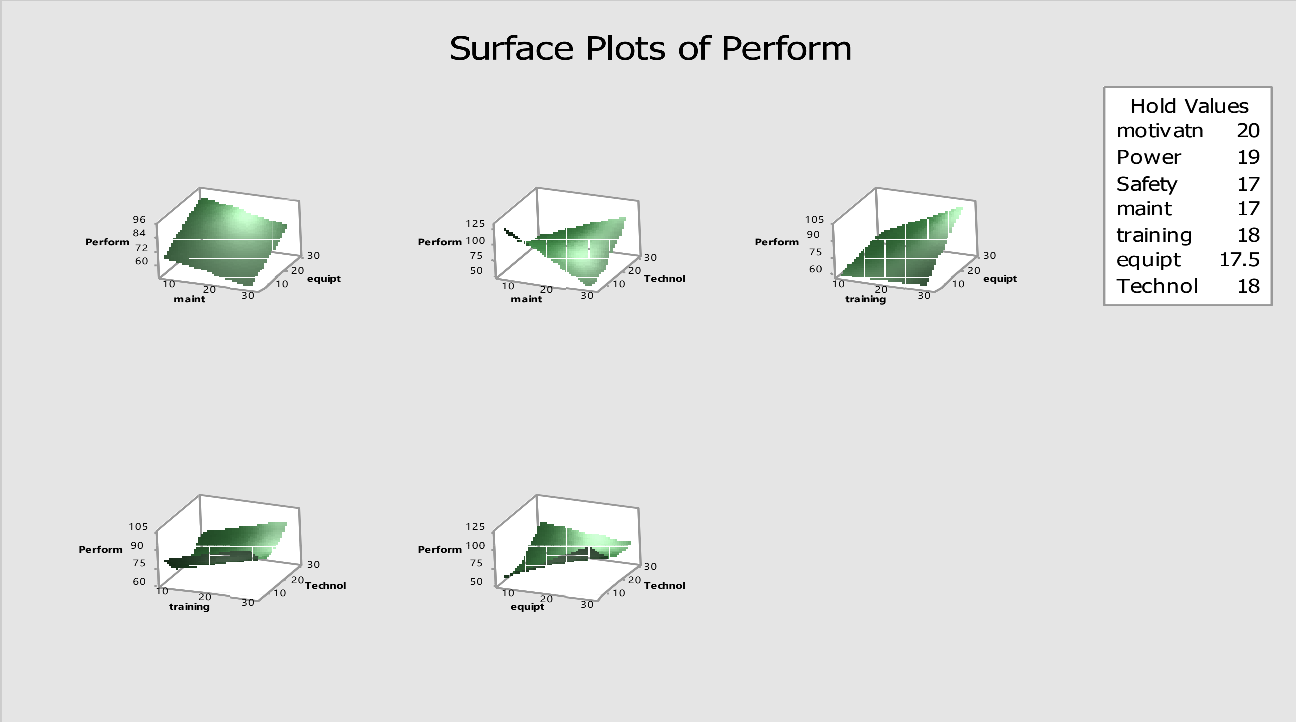


Figure 34: Response Surface Plots of Performance

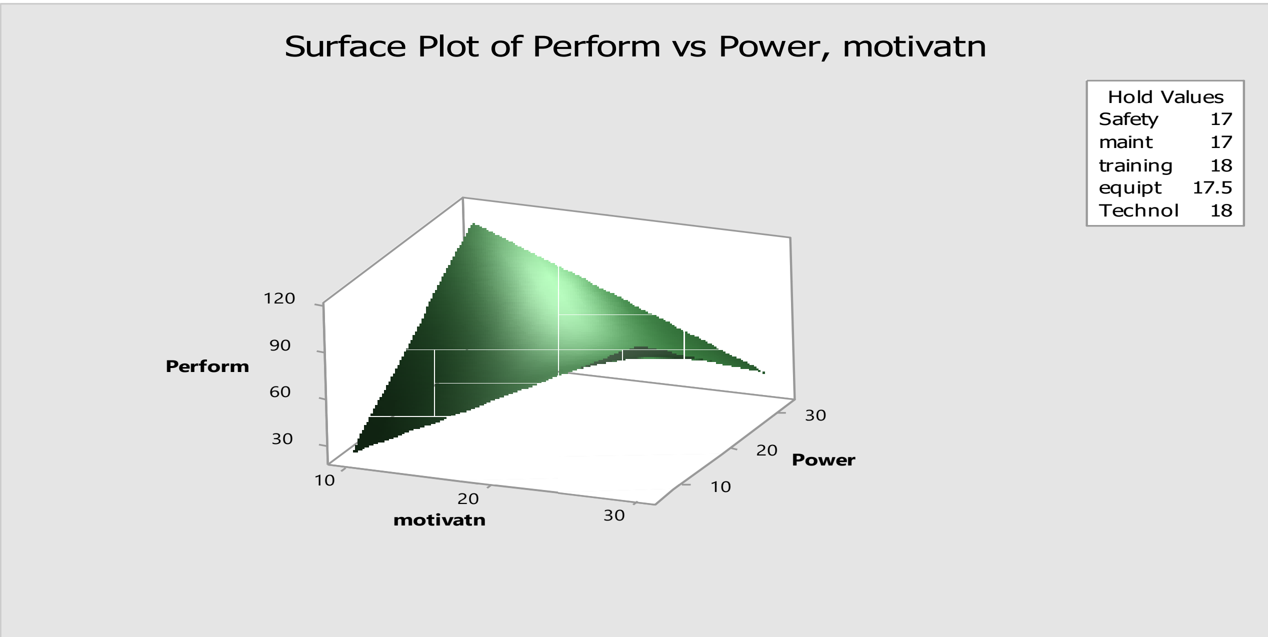


Figure 35: Response Surface plot of Performance Vs Power and Motivation

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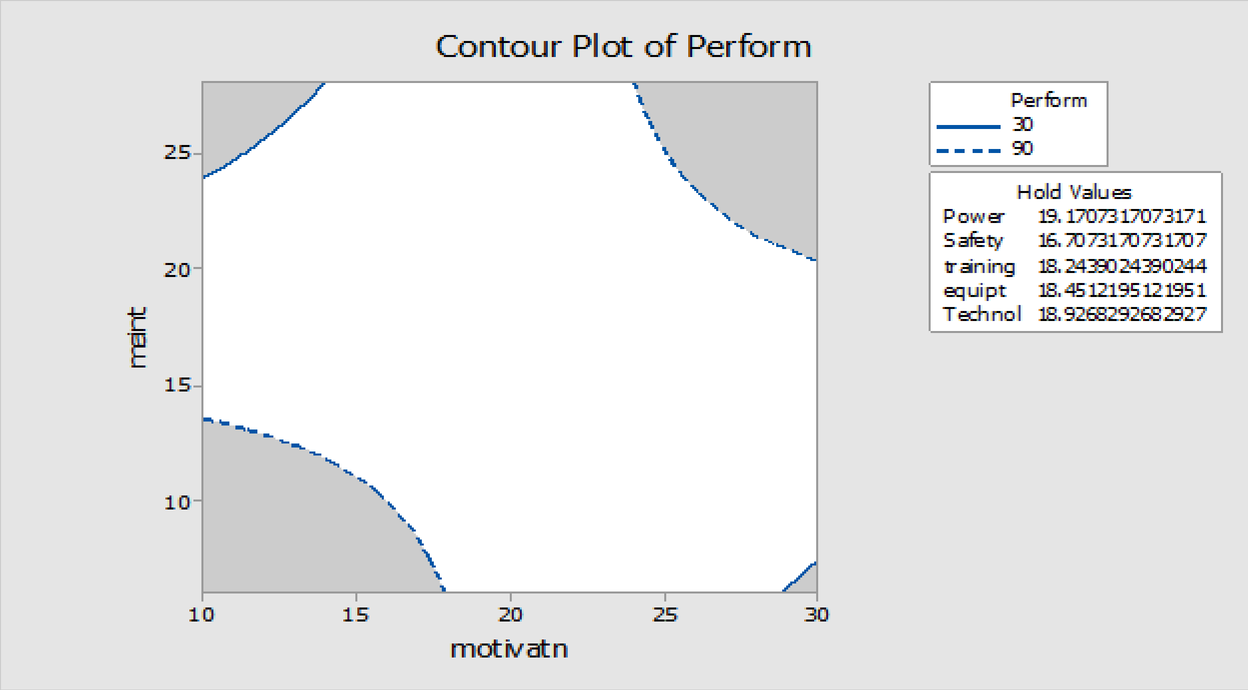

Figure 36: Response Plot of Overlaid Contour of Performance

Response Optimization: Perform

Parameters

Response	Goal	Lower	Target	Upper	Weight	Importance
Perform	Target	32	90	99	1	1

Solution

Solution	motivatn	Power	Safety	maint	training	equipt	Technol	Perform Fit	Composite Desirability
1	29.8962	32	6.11854	27.2485	12.2122	29	6	90	1

Multiple Response Prediction

Variable	Setting
motivatn	29.8962
Power	32
Safety	6.11854
maint	27.2485
training	12.2122
equipt	29
Technol	6

Print ISSN: ISSN 2055-6551(Print), Online ISSN: ISSN 2055-656X(Onlin

Response	Fit	SE Fit	95% CI	95% PI
Perform	90.0	12.0	(65.9, 114.1)	(65.5, 114.5)

Figure 37: SAS print out of Response Optimization: Performance

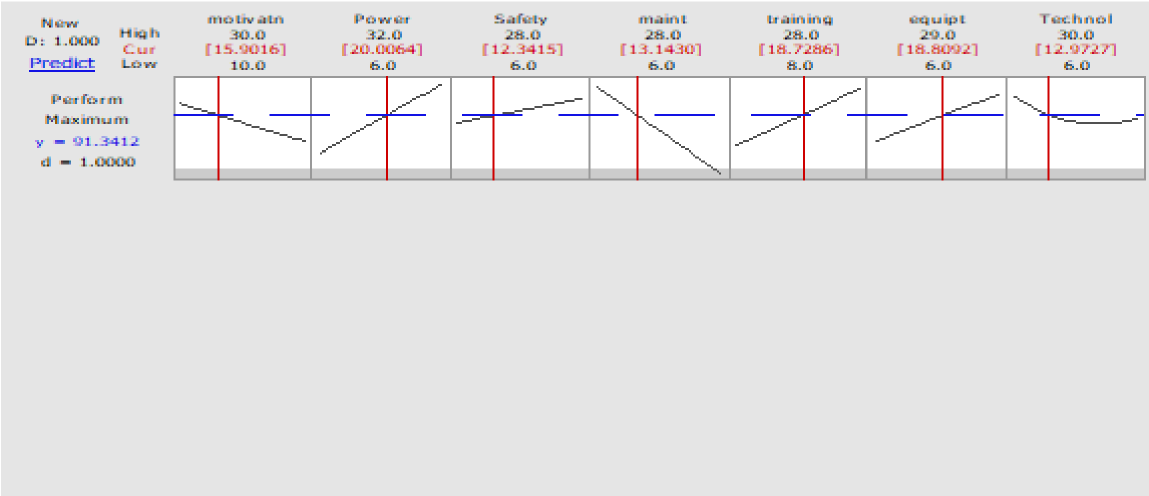

Figure 38: Response Optimization Curves Plot

DISCUSSION OF RESULTS

Polynomial Regression

From the tables of polynomial regression are the representations of the comparative studies of the polynomial regression analysis of the factors that affect the workers in industries. It is needful to know the relationships that exist among the response curves and their strength in the respective data sets. The print out curves reveal the nature of randomly spread of data about the regression lines. The R^2 indicates the account of factor percentage of the variation in the performance. A visual inspection of the plot reveals that the data are randomly spread about the regression line, implying no systematic lack-of-fit. The 95% confidence limits (95% CI) for the performance and the 95% prediction limits (95% PI) for new observations are also shown. The SAS print out shows the nature and the strength of the equation of curves, as a result of the strength of the F-values and P-values in the Sequential Analysis of Variance.

In this response polynomial curves generated in figure 23, that the linear models (p =0.000 or actually p-value =0.05) appear to provide a good fit to the data. The R^2 indicate the variation of factor technology, account for (75.4) % of the variation in the performance. The sequential analyses of variance show that the equation is strong in linear, weak in quadratic and fairly strong in cubic curves, due to the revealed F-values and p-values in the SAS of the respective print out.

In the response curves generated in figures of 11, 15, 19, and 21 that the linear models (p =0.000 or actually p-value =0.05) appear to provide a good fit to the data. The R^2 indicates the variation of factors motivation, maintenance, training, and equipment account for (89.7, 61.1, 90.5 and

89.5) % respectively of the variation in the performance. The sequential analysis of variance show that the equation is strong in linear, fairly strong in quadratic and weak in cubic curves, due to the revealed F-values and p-values in the SAS print out of the respective print out.

In the response curves generated in figures of 13 and 17 that the linear models (p =0.000 or actually p-value =0.05) appear to provide a good fit to the data. The R^2 indicates the variation of factors maintenance and power account for (61.1 and 63.1) % respectively of the variation in the performance. The sequential analysis of variance show that the equation is strong in linear, strong in quadratic and fairly in cubic curves, due to the revealed F-values and p-values in the SAS print out of the respective print out.

Response Surface Regression Analyses

Because the predictions using linear model of (figures 24 and 25) suggested that a higher-order model is needed to adequately model the performance of the response surface, then it requires the fitting of the full quadratic model. For the full quadratic model, the p-value less (<0.05) for lack of fit will suggest that this model adequately fits the data.

The Analysis of Variance tables (1, 3, and 5) summarized the linear terms, the squared terms, and the interactions . The small p-values for the interactions and the squared terms suggest there is curvature in the response surface. The coefficient tables of (2, 4 & 6) evidenced significance of the coefficient of the factors except technology.

The response surface regression analyses were introduced because the multi-linear regression method is not found adequate in predicting accurately the performance. The characteristic shape factor accounts for the performance with high approximation. There are two or more variables on a surface to see the variability of variables in contributions for performance.

Tables 1 and 2 are the analysis of variance and coefficients respectively which generated out of field data to generate equation 12 that has the components of linear, quadratic and interactions. The print outs are a good one, due to the strength of the t-values, F-values and p-values. The print out was also analyzed at different α-values of 0.05, 0.1 and 0.15 and their outputs are shown as in equations 12, 13, and 14 respectively. Prediction of performance was done alike on those α- values, the fits value are presented as in sections 4.1.4.1, 4.1.4.2, and 4.1.4.3. They predicted performance with a good fit.

Considering the interaction plot for performance response, there are nine possible interactions among the factors are as seen in the equation 14 and figure 31. The interaction plots confirm the significance of the pair of the factors. Interactions occur when one factor does not produce the same effect on the response at different levels of another factor. Therefore, if the lines of the two factors are parallel, there is no interaction, and when the lines are far from being parallel, the two factors are interacting. Looking into table 6, the interaction between training and equipment, the p-value of $(0.111) > 0.05$ is insignificant, and looking into the interaction plot of figure 31, it is observed that the interaction lines are parallel. Therefore, those factors that are not interacting are insignificant in affecting the performance.

In the contour plot of interactions between two factors, generated as in figure 32, is a two dimensional system, that when two factors are being considered, others are to be held; in so doing performance is determined based on the two factors. From the contour plot of figure 33 the highest performance produced between safety and motivation is at left top corner and right bottom corner of the plot at performance > 100%.

Print ISSN: ISSN 2055-6551(Print), Online ISSN: ISSN 2055-656X(Onlin

Response surface plots of performance against the two interacting factors are three dimensional systems in which two factors maintain their respective bearing in x- and y- directions and performance in z-direction. To determine the performance, the parallel lines of x- and y- values meeting point, is moved parallel to z-direction to meet the curve at a point defining the value of performance from the values of x and y taken. The response surface plot of performance is seen in figures of (34 and 35). The figure of 34 presents all pairs of interaction factors to performance as found in this study; while the figure 35 is the interaction for the factors: motivation and power on performance. At 95% performance, motivation and power maintained the values of (10, 30) respectively.

The response overlaid contour plot of performance, figure 36, the regions in the corners of the plot show the range of the factors, maintenance and motivation where the criteria for both response variables (90 and 30) are satisfied. It is possible to increase or decrease the holding values to see the range of change. The feasible regions formed by the factors, should be repeated to obtain all pairs of the factors.

The response optimization of performance of figure 37, which is the SAS print out of variability set. The individual desirability of factors is 1.000. Therefore, the combined or composite desirability of these variables is 1.000. To obtain this desirability, set the factor levels at the values shown under Solution. To adjust the factor settings of this initial solution, you can use the plot. Move the vertical bars to change the factor settings and see how the individual desirability of the responses and the composite desirability change (see figure 38).

The combined or composite desirability of these variables at the current factors setting with red coloured values gives the performance value of 91.3%.

Test Results of the Hypotheses

Table 1, answered the first hypothesis that the performance of manufacturing workers in plastic industries is affected by the studied factors except the technological factor that has less significance.

Table 2, proves that the coefficients of the independent variables in the regression models can predict the model effectively, with the exception of the technology factor. Even the coefficients of the quadratic and interaction factors were proved significant.

The quantitative values of the various parameters measured as prediction for performance, interaction and combined effect coefficients fit adequately in establishing the manufacturing workers performance as the values of p-values are significant.

In the prediction of performance using equations 15 – 18, the fit in the multi-linear regression as seen in equation 15 is smaller relative to the prediction in the response surface regression of the generated models of equations 16-18. The multi-linear regression fit generated value is 81.28% as against surface response regression models at various p-values ($\alpha = 0.05$, 0.1 and0.15) are evaluated as (85.25, 85.25 and 85.03) % respectively, for a given set of condition.

Figure 31, shows the interactions within the combined factors and intensified effects on the performance of workers. The increase in performance of manufacturing workers in plastic industries is due to these cumulative effects of factors. The magnitude of these effects of the combined and interaction is 42.57% ($\alpha = 0.15$), 43.67% ($\alpha = 0.1$) and 43.67% ($\alpha = 0.05$) compared with the multi linear values of 80% and above.

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Contributions to Knowledge

1. The research identifies some of the specific factors responsible for poor performances of manufacturing workers in industries. Such factors as are: motivation, power, safety, maintenance, training, equipment and technology*, as all except one is significant.
2. The study discovered the effects of the combined- factors and their interactions on the performance of manufacturing workers in the manufacturing industries and provides the models that perfectly predict performance.
3. Results such as: models generated, correlation coefficients, Variance of inflation factor, Durbin – Watson coefficient and co – linearity of the factor are applied in controlling engineering management problems, decision- making, and enacting management and government policies formulation.
4. The results serve as information to use in improving the work force (workers) conditions of service, by the percentage contribution of factors' coefficients in the linear order model that revealed where improvement is needed the more.
5. Finally, the study offers quantitative solutions to problems of manufacturing workers in industries, taking cognizance of the developed models' coefficients thereby nullifying guess work in operations.

CONCLUSION

Successful determinations of the combined-effects of factors on the performance of manufacturing workers in industries have been achieved.

It was found that the factors such as: Motivation, Power, Safety, Maintenance, Training, and Equipment affected the performance of manufacturing workers in manufacturing plastic companies;

The regression coded coefficients as shown in tables showed the different factors, their combination and interactions effects contribution on the performance and their cumulative effects contribution vary with confidence interval

Different models were developed and validated and it was found that the quadratic - shape - factor models are best to predict the performance of the manufacturing workers.

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APPENDIX - A

Overall Data for All the Three Industries Chosen For the Study

Workers	Motivatn	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

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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

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