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A linear regression approach in the determination of work standards for a manufacturing organisation

S. A. Oke
Department of Mechanical Engineering, University of Lagos, Nigeria
sa_oke@yahoo.com

ABSTRACT
In semi-automated roofing sheets manufacturing plants, production managers receive large orders, which most often, are to be delivered within scheduled delivery dates; failure to deliver orders incurs penalty costs and litigation charges. The challenge therefore for the production manager is to be able to predict product completion period and map available labour man-hours to production of roofing sheet orders. This paper presents a linear regression model for setting up work standards for a roofing sheet manufacturing plant. Linear regression is a relatively established technique in scientific investigations, but new in its applied form to work standards, particularly in roofing sheets manufacturing operations standards setting. The accuracy of the model was determined by the least square method, and the result suggests the feasibility of applying a model in the case presented. Thus, the contribution of this paper lies in the application of a known technique in a new area. The utility of the tool is in its ability to provide useful information for production planning and implementation purposes in the roofing sheets plants.
Keywords: *work standards, regression model, roofing sheets, performance*

1 INTRODUCTION

The challenge of sustaining the continued existence of manufacturing plants has been tackled by a variety of approaches: (1) development and implementation of effective marketing strategies through product promotion, quantity discount, and good after-sales/installation services; (2) production to client specification and to delivery dates in order to avoid heavy penalty losses for and from the client; and (3) creation of good image and goodwill for the company by engaging in community development projects. The first and the third approaches would fail to maintain wooed clients or loyal customers if the second approach is not taken seriously. Thus, production managers in semi-automated roofing sheet manufacturing plants are constantly under serious pressure of keeping to production schedule of orders, and maintaining an effective work team whose performance is measured, rewarded or reprimanded constantly. This pursuit has motivated the application of work standards in the determination of the time to produce work orders. Work standard is a performance standard tool, which has been applied effectively in both manufacturing and service systems for achieving results and set goals (Hui and Frency 1999; Grunberg 2003; Greasley 2003).

Work standard has been traditionally utilised to reveal manufacturing plants weaknesses, strengths, opportunities for improvement, and threats for non-compliance to corrective actions (Edo *et al.*2001). The literature on performance standard setting has been related to several tools and concepts of motion and time study (Meyers and Stewart, 1980; Karger and Bayha 2003; Polk 1984; Doty 1989; Zandin 2003). The fund of knowledge in Aft (2000); Barnes (1980) relating to motion and time study has specifically treated work standard under the time study analysis. The study by Allan *et al.* (1998), Miliward (1967); Rodriguez (1990); Sale (1989) on workstudy also relates to work standard in one form or the other. Work standard has a complimentary research body, which deals with non-standard works. Studies due to Olsen and Kalleberg (2004); Dawkins *et al*. (1986); Spoonley *et al.* (2002). This growing body of knowledge is challenging the traditional concepts and principles of work standards. Olsen and Kalleberg (2004) examine the use of non-standard work arrangements by organization in the United States (US) and Norway. Dawkins *et al.* (1986) considers the supply of non-standard hours of work.

From the above review, it becomes clear that systematic investigations on work standards with reference to batch products are missing. A closely related study was attempted by Oke (2007), which focused on a case application of workstudy in an aluminium hollow-ware manufacturing plant that engages in the production of kettles, frying pans, and cooking pots. Even then, the approach adopted is differential calculus, which does not provide a simplified approach for the production manager of the roofing sheets company. There is therefore a strong need to propose and test an attractive approach for the roofing sheets manufacturing plant investigation. This is pursued in the current study. The structure of the paper is as follows: introduction, methodology, case study and discussion. In section 1, introduction provides the motivation into the study and its justification based on the existing gap that the literature review reveals. Section 2, the methodology, provides the framework for the implementation of the study. A case study that reveals the practical situation is discussed in section 3. The concluding remarks are provided in section 4.

2 METHODOLOGY

In this section, notations and assumptions governing the formulation of the model are discussed. The model development is then systematically presented. The

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development of model covers the three production processes in the roofing sheets company: roll forming, bending, and crimpsin.

2.1 NOTATIONS

y_{ij}: standard time of activity i in period j
x_j: parameter of interest for the measurement period
$x_1, x_2, x_3, x_4, \ldots$ basic variables of the model
$b_0, b_1, b_2, b_3, b_4, \ldots$ constants of the model
$x_{ji}, \ldots, x_{jn}$: values of x_j
y_i: standard time of activity i
Y: standard time per bend
$\hat{Y}$: standard time per rolling/crimpsin
q: sum of the square of difference between y_i and y
$\bar{y}$: means of the y_i values in the sample
$\bar{x}_j$: mean of the x_j values in the sample
k_i: slope of the line y_i against x_{ji} and it is also called regression co-efficient
k_o: intercept of the line y_i against x_{ji}

2.2 MODEL ASSUMPTIONS

Consider a manufacturing system under the following assumptions:

(1) An effective production system is in place, such that the efforts put into the system is directly reflected in the output of the production team

(2) The right number of production personnel with the skills and training necessary for implementing day to day activities are used

(3) There is a defined responsibility for the individual production worker. Hence, production target is in place and monitored

(4) The machines are always in a healthy state. Once broken down they can always be repaired and restored in a negligible time frame and

(5) There is a clear definition and measurement of output. Hence, unit of measurement of production output are known and specified.

If all these assumptions are valid then we can en-vision a new host of variables to which work standard relates. Obviously, this modelling effort is a natural extension of the traditional way of calculating work standard of various jobs. The traditional perspective of work standard calculation hinges on determination of standard time through actual observation. However, our model builds on this to incorporate a predictive element in order to allow for the calculation of the standard time needed to carry out certain activities based on historical data.

The model developed in this work is as stated below: if "y_{ij}" represents the standard time of activity "i" in period "j" and x_j denotes the parameter of interest for the measurement period, then we may have a predictive model of the form

$$y_{ij} = f(x_i) \qquad (1)$$

Since we are investigating a case for a roofing sheet industry, it means that this simple model applies to each of the three processes of bending, rolling, and crimpsin. Depending on the function behaviour of the parameter of interest the function may assume any mathematical expression of linear and non-linear functions. For a clear understanding of our model we limit ourselves to the bending process for the purpose of this explanation. If we take a close look at the basic variables that serve as the components of the bending process, then the following may be mentioned:

(1) Number of bends that would appear on the flat sheet when finished

(2) The length of the sheet measured in meters

(3) The width if the sheet measured in millimetres

(4) The thickness of the sheet measured in millimetres but convertible to meters

If our model is to be fine-tuned to the bending process then each of these four expressions form the basic variables of the model.
Let the variables be represented with notations x_1,x_2,x_3,and x_4. Then we have a linear model of the form:

$$y_i = b_o + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 \qquad (2)$$

where b_0,b_1,b_2,b_3 and b_4 are constants of the model.

This model is a first order linear expression. Higher others could be obtained by varying the powers of x_i's. By the same argument, a non-linear expression for the model could be stated as

$$y_i = (b_o)(b_1x_1)(b_2x_2)(b_3x_3)(b_4x_4) \qquad (3)$$

Based on all these variables, the standard time could be determined in seconds or minutes. Arising from our calculation could be the standard time per bend. We could also calculate the running (rolling) per shift as well as the weight per shift. For the rolling process, modelling the system is slightly different from that of the bending. In general, the following elements also influence our calculation:

(i) the number of observations considered;
(ii) total number of observed time;
(iii) average observe time;
(iv) performance rating;
(v) basic time; and
(vi) allowance.

The explanations for each of these terms are given below:
Number of observation considered: The number of observation considered refers to the numbers of operational work that the observed operator does within a specified time range. In this work, the time range for the observation was 8 hours. More explanatorily, considering a drilling operator, the number of observations considered in

a specified time range will be the amount of drill operations he did within that time frame.

Total number of observed time: This is the total number of hours that the operator spends on productive operation with a specified time range. Productive operation refers to the operation that the operator is paid to do within the specified time range. It can be easy obtained by the summation of the time spent on each operation with the specified time range.

Average observed time: This is a representation of the time the worker spends on one operation. It can be gotten as the ratio of the total number of observed time and the number of observation within a specified time range. It has the unit of time.

Performance rating: This is the relative performance of the operator observed to that of an ideal operator (efficient). The measure of performance of the operator could be the number of observation considered, total number of observed time or average observe time. Performance rating is relative that it can be expressed that the performance of ideal operator is 100% therefore the performance of the observed operator will be less than 100%. Performance rating is analogous to efficiency of the worker.

Allowance: It is the time left between each operation or it is non-productive time. Allowance has the unit of time. It can be expressed as the difference between the total time range (i.e. 8 hours) and the total number of observed time. The operator takes breaks in between operations to eat or do some other things. This time frame of the worker not being productive is the allowance time.

Basic time: This is the actual time that an operator does work without allowance.

In developing the model work standards data from actual production operations were collected. The historical work standard data and the model results for the various processes are shown in Table 1, starting with the bending process.

Table 1. Work standards database (Performance Rating = 95%)

Number of Bends (x_1)	Number of Observations (x_2)	Total Observed Time	Average Observed Time	Basic Time	Allowance	Standard Time
3	1	6	6.00	5.70	0.97	6.67
3	5	55	11.00	10.45	1.78	12.23
3	1	18	18.00	17.10	2.91	20.01
3	5	37	7.40	7.03	1.20	8.23
4	3	28	9.33	8.87	1.51	10.38
4	15	133	8.87	8.42	1.43	9.85
6	3	45	15.00	14.25	2.42	16.67
7	4	50	12.50	11.88	2.02	13.90
7	1	7	7.00	6.65	1.13	7.78

The linear model suggested above was applied to the data. Thus, resulting in six sets of equations for the bending process (Table 2). It should be noted that table 1 produces only the first element of Table 2 (i.e. place sheet in machine). Therefore, in order to develop the linear model for the other five activities we obtained similar data to table 1 for experimentation. An interesting dimension of the model is varying the order of the equations. A second order work standards model for the bending operation could thus be formulated such that if "y" is differentiated with respect to the component variables, we may establish different sets of equations.

Table 2. Bending Process

Equation	Description of activities
$Y = 21.849 + 0.1269(x_1) – 0.158(x_2)$	Place sheet on machine
$Y = 82.76 + 32.895(x_1) + 713(x_2)$	Bend sheet
$Y = 0.921 + 10.72(x_1) – 0.0979(x_2)$	Measure length to bend
$Y = 12.23 + 0.034(x_1) + 0.029(x_2)$	Pick sheet to machine
$Y = 465.7 + 3.01(x_1) + 150.7(x_2)$	Carry sheet to store
$Y = 1.801 + 0.203(x_1) + 0.051(x_2)$	Stocking of sheet by side

For example in the case of "place sheet on machine" the relationship between x_1 and x_2 is represented as

$$y = 0.2538(x_1)^2 – 0.158(x_2) \qquad (4)$$

If this equation is differentiated with respect to x_1, then we have:

$$x_1 = 0.7890\sqrt{x_2} \qquad (5)$$

This means that in order to find the number of bends that a set standard time could permit, you only need to know the number of observations involved. For instance in the case of 15 observations the number of bends for the optimal level of performance will be $0.7890(\sqrt{15}) = 3$ bends.

A variance of these could be obtained if factored. If we consider the making a factor of x_2, then we have the equation

$$y = 0.2538(x_1) - 0.158(x_2)^2 \qquad (6)$$

The summarised results of the second order equations for the bending process are shown in Table 3. For the rolling process we have a set of equations for the first and second order linear equations shown (Tables 4 and 5). By applying the same approach to the crimpsin process we have a new set of equations in Tables 6 and 7.

Table 3. Second order equation for Bending process (x_1 and x_2 are second order variables)

Equation	Description
$Y = 0.2538(x_1)^2 – 0.158(x_2) = 0$; $Y = 0.2538(x_1) - 0.158(x_1)^2 = 0$	Place sheet on machine
$Y = 65.7906(x_1)^2 - 713(x_2) = 0$; $Y = 65.7906(x_1) + 713(x_2)^2 = 0$	Bend sheet
$Y = 21.44(x_1)^2 - 0.0979(x_2) = 0$; $Y = 21.44(x_1) - 0.0979 (x_2)^2 = 0$	Measure length to lead
$Y = 0.068(x_1)^2 - 0.029(x_2) = 0$; $Y = 0.068 (x_1) + 0.029(x_2)^2 = 0$	Pick sheet on machine
$Y = 6.02(x_1)^2 - 150.7 (x_2) = 0$; $Y = 6.02(x_1) + 150.7(x_2)^2 = 0$	Carry sheet to store
$Y = 0.406(x_1)^2 - 0.051(x_2) = 0$; $Y = 0.406(x_1) + 0.051(x_2)^2 = 0$	Stocking of sheet by side

Table 4. Rolling process

Equation	Description
$\hat{Y} = 950.09 + 188.91(x_1) - 0.13(x_2)$	Sheet running on machine
$\hat{Y} = 63 + 0.26(x_1) – 0.06(x_2)$	Stocking sheet by side

Table 5. Second order equation for Rolling process (x_1 and x_2 are second order variables)

Equation	Description
$\hat{Y} = 376.82(x_1)^2 - 0.13(x_2) = 0$; $\hat{Y} = 188.91(x_1) - 0.26(x_2)^2 = 0$	Sheet running on machine
$\hat{Y} = 0.52(x_1)^2 - 0.06(x_2) = 0$; $\hat{Y} = 0.26(x_1) - 0.12(x_2)^2 = 0$	Stocking sheet by side

Table 6. Crimpsin process

Equation	Description
$\hat{Y} = 3.97 - 0.075(x_1) + 0.94(x_2)$	Pick sheet from floor to machine
$\hat{Y} = 68.98 + 0.13(x_1) - 8.47(x_2)$	Set up sheet on machine
$\hat{Y} = 3790.4 - 10.72(x_1) – 435.40(x_2)$	Crimpsin operation
$\hat{Y} = 36.34 - 0.28(x_1) - 5.53(x_2)$	Carry sheet to store

Table 7. Second order equation for Crimpsin process (x_1 and x_2 are second order variables)

Equation	Description
$\hat{Y} = 0.150 (x_1)^2 - 0.94(x_2)$; $\hat{Y} = 0.075(x_1) - 1.88(x_2)^2$	Pick sheet from floor to machine
$\hat{Y} = 0.26 (x_1)^2 - 8.47(x_2)$; $\hat{Y} = 0.13(x_1) - 16.54(x_2)^2$	Set up sheet on machine
$\hat{Y} = -21.44 (x_1)^2 - 435.40(x_2)$; $\hat{Y} = -10.72(x_1) - 870.80(x_2)^2$	Crimpsin operation
$\hat{Y} = -0.56 (x_1)^2 - 5.53(x_2)$; $\hat{Y} = -0.28(x_1) - 11.06(x_2)^2$	Carry sheet to store

2.3 DETERMINATION OF THE ACCURACY OF THE MODEL

It is assumed that the x_j-values $x_{ji}, \ldots, x_{jn}$ in the sample $(x_{ji}, y_i), \ldots, (x_{jn}, y_n)$ are not all equal. The model $y_i = f(x_{ji})$ can be expressed in both linear and non-linear forms. Using the least square method to determine the accuracy of the formula. Taking the approximation function in the form:

$$y = k_o + k_i x_j \qquad (7)$$

The difference $(y_i – y)$ should be small for high accuracy, i.e. $y_i – y = y_i – (k_o + k_i x_{ji})$, where $j = 1, 2, 3, 4$. The sum of the squares of these differences is:

$$q = \sum_{i=1}^{n}\left(y_i - k_o - k_i x_{ji}\right)^2 \qquad (8)$$

Differentiating (8) with k_o ad k_i respectively:

$$\frac{\partial q}{\partial k_o} = -2\sum\left(y_i - k_o - k_i x_{ji}\right) = 0 \qquad (9)$$

and $$\frac{\partial q}{\partial k_i} = -2\, x_{ji}\sum\left(y_i - k_o - k_i x_{ji}\right) = 0 \qquad (10)$$

Equations (9) ad (10) become equations (11) ad (12) respectively,

$$k_o n + k_i \sum x_{ji} = \sum y_i \qquad (11)$$

$$k_o \sum x_{ji} + k_i \sum x_{ji}^2 = \sum x_{ji}\, y_i \qquad (12)$$

Equations (11) and (12) are linear system of two equations in the two unknown k_o and k_i. Its coefficient determinant is:

$$\begin{vmatrix} n & \sum x_{ji} \\ \sum x_{ji} & \sum x_{ji}^2 \end{vmatrix} = n\sum x_{ji}^2 - \left(\sum x_{ji}\right)^2 \qquad (13)$$

But from the simple regression line the formula:

$$y - \bar{y} = k_i\left(x_j - \bar{x}_j\right)$$

where $\bar{x}_j$ and $\bar{y}$ are the means of the x_j- ad y-values in the sample

$$\bar{x}_j = \frac{1}{n}\left(x_{ji} + \ldots + x_{jn}\right) \text{and } \bar{y} = \frac{1}{n}\left(y_i + \ldots + y_n\right)$$

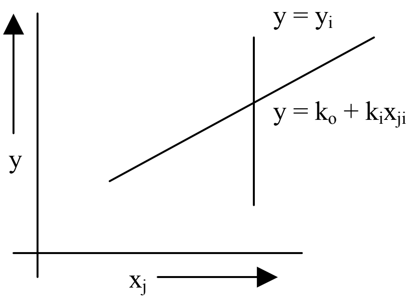

Figure 2. Graph indicating trend in linear equation

and the slope k_i, called regression coefficient is given by:

$$k_i = \frac{Sx_j y}{Sx_j^2} \qquad (14)$$

with the "sample covariance" $Sx_j y$ given by:

$$Sx_j y = \frac{1}{n-1}\sum_{i=1}^{n}\left(x_{ji} - x_j\right)\left(y_i - \bar{y}\right) =$$

$$\frac{1}{n-1}\left[\sum_{i=1}^{n} x_{ji} y_i - \frac{1}{n}\left(\sum_{i=1}^{n} x_{ji}\right)\left(\sum_{i=1}^{n} y_i\right)\right]$$

and $$Sx_j^2 = \frac{1}{n-1}\sum_{i=1}^{n}\left(x_{ji} - \bar{x}_j\right)^2 =$$

$$\frac{1}{n-1}\left[\sum_{i=1}^{n} x_{ji}^2 - \frac{1}{n}\left(\sum_{i=1}^{n} x_{ji}\right)^2\right] \qquad (15)$$

Thus, $$\begin{vmatrix} n & \sum_{i=1}^{n} x_{ji} \\ \sum_{i=1}^{n} x_{ji} & \sum_{i=1}^{n} x_{ji}^2 \end{vmatrix} = n\,(n-1)\, Sx_j^2 = n\sum\left(x_{ji} - \bar{x}_j\right)^2$$

Equation (15) is not zero with the above assumption. Hence, the system has a unique solution.

From equation 11-12, we have:

$$\begin{bmatrix} n & \sum x_{ji} \\ \sum x_{ji} & \sum xj_i^2 \end{bmatrix}\begin{bmatrix} k_o \\ k_i \end{bmatrix} = \begin{bmatrix} \sum y_i \\ \sum x_{ji} y_i \end{bmatrix} \qquad (16)$$

By Crammer's rule, $$k_i = \frac{n\sum x_{ji} y_i - \sum x_{ji}\sum y_i}{n\left(n-1\right)Sx_j^2} \qquad (17)$$

From equation (11) $nk_o + k_i \sum x_{ji} = \sum y_i$

Dividing through by n and substituting $n\bar{y}$ for $\sum y_i$ and $n\bar{x}$ for $\sum x_{ji}$ respectively, $k_o = \bar{y} - k_i \bar{x}_j$ (18)

Case 1: j = 1, $k_i = \frac{Sx_1 y}{Sx_1^2}$, and $k_o = \bar{y} - k_i \bar{x}_i$

Case 2: j = 2, $k_i = \frac{Sx_2 y}{Sx_2^2}$, and $k_o = \bar{y} - k_i \bar{x}_2$

Case 3: j = 3, $k_i = \frac{Sx_3 y}{Sx_3^2}$, and $k_o = \bar{y} - k_i \bar{x}_3$

Case 4: j = 4, $k_i = \frac{Sx_4 y}{Sx_4^2}$, and $k_o = \bar{y} - k_i \bar{x}_4$

3 CASE STUDY

The case study roofing sheets manufacturing organisation (Figure 1) has it administrative and operational control vested in the General Manager, under the broad policy direction of the Managing Director of the group to which the unit is a member. Colours and sizes specify roofing sheets. Customer orders could be for plain or coloured (blue, pale green, red) roofing sheets. The specifications of roofing sheets by sizes are in width (girth), length, and thickness. The girth are usually between 1000mm and 1200m, while the length could be as low as 0.5 metres or significantly higher. The thickness ranges from 0.35mm to 0.55mm. Thus an order could be in the form: thickness x width x length. For bent products, the specification is usually in terms of number of bends. Usually, bent products are made from already processed roofing sheets. Also, roofing sheets that are processed are used for the crimpsin process, in which the parameter of interest is number of crimps. Primarily, the bending and roll forming processes consist of three activities each coil-loading, machine running time, and unloading times. The results show that on the average coil loading time was 12 minutes; coil offloading time takes about 2 minutes, and machine running time per metre averages 3 seconds. For the roll forming crew/shift has the capacity to produce up to 14.88.8 tons of roofing sheets with a thickness and width of 0.45mm and 1,200mm respectively. For a 0.55mm x 1,200mm sheet, a crew/shift can produce up to 18.197 tons. Furthermore, for a diversion of 0.55mm x 1,000mm sheet, 15.164 tons is achievable. For the bending process, the standard time per bend is 35.36 seconds for a thickness of 0.45mm. The achievable production capacity per shift is 0.857 tons per shifts. On the average, the standard time per bend is 34.37 seconds.

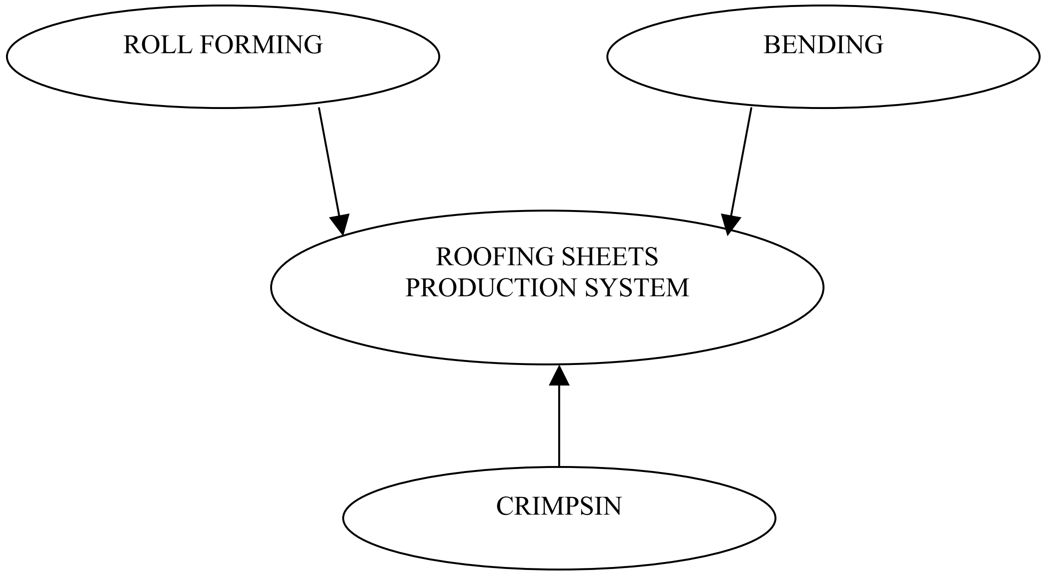

Figure 1. The production process for roofing sheets

3.1 MODEL ACCURACY TESTING

In order to test the accuracy of the model, data collected from real field observation were tested as stated in Table 8. Note that x_{1i}^2 and $x_{1i}y_i$ are auxiliary values; n =

Table 8. Test data for case 1: x_{1i} and y_i

S/N	x_{1i}	y_i	x_{1i}^2	$x_{1i}y_i$
1	3	1	9	3
2	4	15	16	60
3	6	3	36	18
4	4	3	16	12
5	3	5	9	15
6	7	4	49	28
7	7	1	49	7
8	3	1	9	3
9	3	5	9	15
$\sum$	40	38	202	161

3.2 MODEL SENSITIVITY ANALYSIS

The usual practice in model development is to find out the responsiveness to changes of some parameters embedded in the model. As such, the robustness of the model could be tested. In addition, the reliability of the estimated values could be ascertained. The predictive model discussed in this work was tested for sensitivity using some of the parameters in the model developed. In order to have a clear picture of the model sensitivity to changes of the parameters, we varied the parameters by some accounts, usually at 5% increase or decrease in value

9, $\sum_{i=1}^{n} x_{1i}^2 = 202$, $\sum_{i=1}^{n} x_{1i}y_i = 161$. Since $\bar{x}_1$ = 4.44, and $\bar{y}_1$ = 4.22, therefore Sx_1^2 = 3.027, Sx_1y = -0.986, k_1 = -0.3257, k_o = 5.67, therefore y = 5.67 – 0.3257x_1.

of input. We then noticed the corresponding changes in the output. The result of the variations is displayed in Table 9.

4 CONCLUSION

In this paper, we have presented a new method to estimating the standard times for bending, roll forming and crimpsin operations in a roofing sheet manufacturing organization. The linear regression model is used for the estimation of the amount of time it will take to complete jobs based on simple linear, second order with x_1 and x_2 independently powered to second order. The error each of these sets of equations gives is then compared to conclude on the simple linear equation as giving the best results. From Tables 3 to 7, we can see that the proposed model can establish standards more accurately than the existing (traditional) approach. In this paper, we assume a linear relationship among variables. However, the proposed model also can be extended to incorporate additional attributes that would enhance both the accuracy of the model and its credibility among modellers. The job performance rating, which is subjective may be appropriately captured using uncertainty-capturing tools such as neuro-fuzzy or fuzzy logic. Apart, the whole system could be computerized, and ported over the Internet for multinational organisations, which desire to utilize the data from anywhere. Therefore, a more accurate standardization can provide the factory managers a strong basis to make right decisions.

Table 9. Sensitivity Analysis of x_1 and x_2 (bending process)

	x_1 (bending process)		x_2 (bending process)	
Input Changes (%)	Value of ŷ	Output Changes (%)	Value of ŷ	Output Changes (%)
5	-6538.46	1	-6896.68	7
10	-6615.65	2	-7332.08	13
15	-6692.83	4	-7767.48	20
20	-6770.02	5	-8202.88	26
25	-6847.20	3	-8638.28	33
30	-6924.38	7	-9073.68	40
35	-7001.57	8	-9509.08	47
40	-7078.75	9	-9944.48	54
45	-7155.94	11	-10379.88	61
50	-7233.12	12	-10815.28	67
55	-7310.30	13	-11250.68	74
60	-7387.49	14	-11686.08	81
65	-7464.67	15	-12121.48	88
70	-7541.86	16	-12556.88	94
75	-7619.04	18	-12992.28	101
80	-7696.22	19	-13427.68	107
85	-7773.41	20	-13863.08	114
90	-7850.59	22	-14298.48	121
95	-7927.78	23	-14733.88	128
100	-8004.96	24	-15604.68	142

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