ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijircce.com

Vol. 6, Issue 5, May 2018

Production Improvement using Predictive Planning

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ABSTRACT: Advanced order planning is a need in corrugation and other industries. Planning the orders according to the time required can help the business grow. Predicting the time is necessary for the orders to be planned. Various process are involved in production cycle in a corrugation industry. Time required for each process depends on multiple factors and parameters. Analyzing the behavior of each factor and deriving relations of it on how the time value changes with the change in these factors is an important part of the project. Time required for each process then needs to be summed up for calculating the total time of an order. This predicted time then can be used to plan the order in an efficient way. Analyzing the orders and predicting the time required will enhance the speed of production and reduce human efforts and errors caused in planning as in the present scenario.

KEYWORDS: Business analysis, Production planning, Prediction, Regression, MultipleRegression.

I. INTRODUCTION

The main aim of the project is to predict the time required for the production. Ordinary shipping containers require printing and labels to identify the contents, provide legal and regulatory information, and bar codes for routing. Boxes that are used for marketing, merchandising, and point-of- sale often have high graphics to help communicate the contents. Some boxes are designed for display of contents on the shelf. Others are designed to help dispense the contents. Popular for their strength, durability, lightness, recyclability, and cost-effectiveness, corrugated boxes are used for the shipping of a variety of items. Due to the quality and safety of packaging items in corrugated boxes, they are used widely in the food industry. The boxes handle the pressure that comes with stacking, making them ideal for easy transporting.

The proposed system helps the administrator to smartly analyse the order according to its need and/or demand. The analytic report helps in future planning of the order. Predictive planning is useful for using the machines to its full potential without any of it being idle at any given time. Using multiple regression algorithm for predicting the output time of current order in machine will help in future order planning. The administrator can remotely gain any type of information regarding current state of individual machine, current process of specific order and time required for completion of ongoing process.

II. RELATED WORK

In paper [5], the authors conducted an experiment to check the quality of a product in an industry by using regression analysis. Similarly, in this project we are checking the time required for a particular production by using multiple linear regression as stated by the authors. Multiple linear regression is performed on all the processes using paper [4] and paper [2]. These are the ordinal least squares method and gradient descent method.

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In ordinal least square method, we can find the linear relation between a dependent and independent variable as **Y=β0+β1X** ,where β0 (intercept) and β1 (slope). Gradient descent is a way to minimize an objective function J. There are three variants of gradient descent, which differ in how much data we use to compute the gradient of the objective function. Depending on the amount of data, we make a trade-off between the accuracy of the parameter update and the time it takes to perform the update.

Hence time is predicted for the entire production using the methods mentioned above.

III. PROPOSED ALGORITHM

The main aim of the project is to predict the time required for the production.
Prediction algorithms are
• Naive Bayes
• Support Vector Machines
• Decision Tree
• K-Nearest Neighbour
• Regression Analysis.

The need is to predict the time as discrete values and not as a range. No other algorithmexcept regression can predict the values using some variables on which time dependson. Hence we choose regression. The system consist of various processes. Each process time is predicted individually by using multiple regression. Various processes consist of various independent variables that contribute in calculating the time required for that process. Sum of all the selected processes hence will provide us the total predicted time of an entire order.

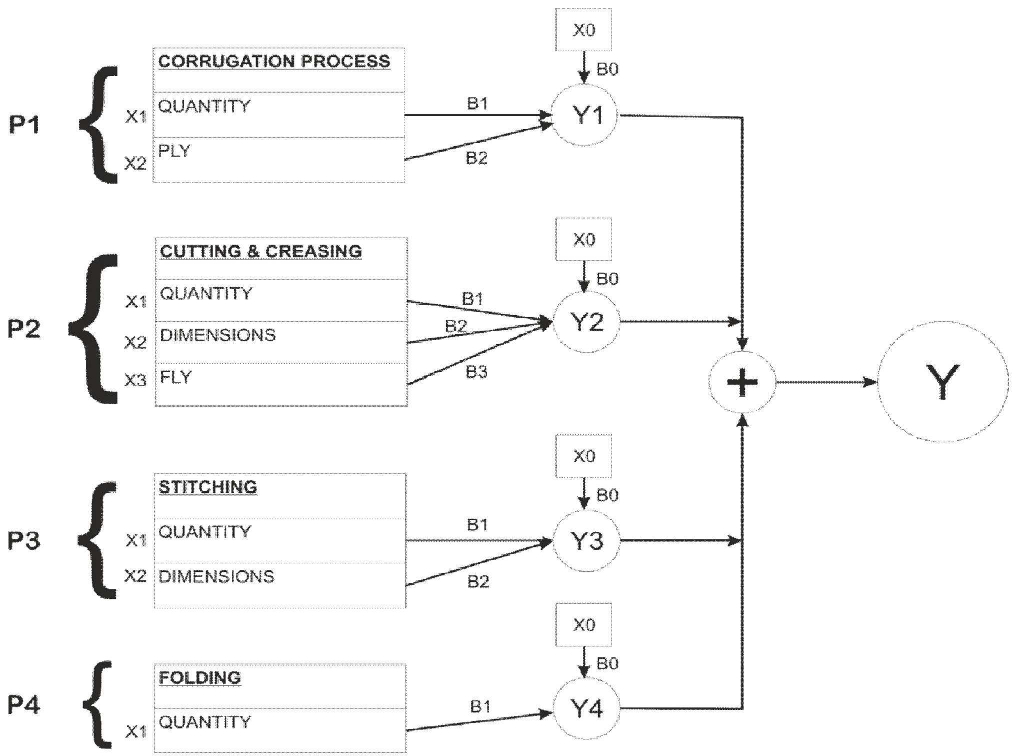

Fig. 1. Various processes in production

Multiple regression for a particular process is calculated using y i = B 0 + B 1 x i1 + B 2 x i2 + ...+ B p x ip + E

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where i = 1,2, ..., n. Here, i represents the process number. For each process, our x(independent variable) and B(Regression Coefficient) will change according to the process. For processes in the production, the total time of production will be y = y 1 + y 2 +y 3 + y 4. For each process, the independent variables change but the dependant variable remainssame in terms of time. B(Coefficient for regression) values also change as the model will be mapped for each of the processes in the production and that model will predict the time required for each individual process.

IV. ACTUAL FLOW OF CONTROL

Ordinal Least Square and Gradient Descent Methods have been used for prediction using multiple linear regression. In ordinal least square method, we can find the linear relation between a dependent and independent variable as **Y=β0+β1X** ,where β0 (intercept) and β1 (slope).Let's say we have few inputs and outputs. And we plot these scatter points in 2D space.We want to minimize the error of our model. A good model will always have least error.The error of each point is the distance between line and that point.

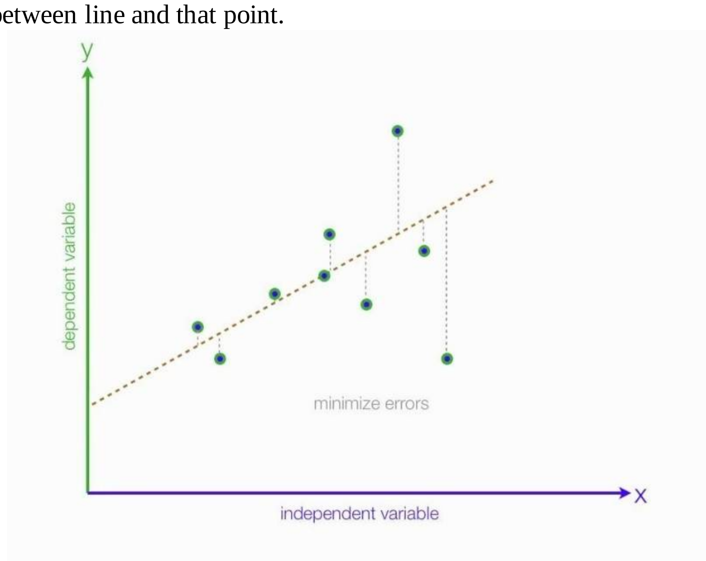

Fig. 2. Graph for minimising errors

Total error of this model is the sum of squares of errors of all points. ie.

$$D = \sum_{i=1}^{m} d_i^2$$

Here, di is the distance between line and i^{th} point.
m = total no. of points
We can minimize the error in the model by minimizing D. And after the mathematics of minimizing D, we will get;

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$$\beta_1 = \frac{\sum_{i=1}^{m}(x_i - \bar{x})(y_i - \bar{y})}{\sum_{i=1}^{m}(x_i - \bar{x})^2}$$

$$\beta_0 = \bar{y} - \beta_1 \bar{x}$$

In these equations, $\bar{x}$is the mean value of input variable **X** and $\bar{y}$ is the mean value of output variable **Y**.

In gradient descent method, We can represent this linear model as follows- $y_i = B_0 + B_1 x_{i1} + B_2 x_{i2} + ... + B_p x_{ip}$
Now we can convert this equation to matrix form.

$$Y = \beta^T X$$

$$\beta = [\beta_0 \quad \beta_1 \quad \beta_2 \quad .. \quad \beta_n]^T$$

$$X = [x_0 \quad x_1 \quad x_2 \quad .. \quad x_n]^T$$

We have to define the cost of the model. Cost basically gives the error in our model. **Y** in above equation is the our hypothesis(approximation). We are going to define it as our hypothesis function.

$$h_\beta(x) = \beta^T x$$

$$J(\beta) = \frac{1}{2m} \sum_{i=1}^{m} (h_\beta(x^{(i)}) - y^{(i)})^2$$

Here, J(β) is our cost function. By minimizing this cost function, we can get find β. We use **Gradient Descent** for this. Gradient Descent is an optimization algorithm. We will optimize our cost function using Gradient Descent Algorithm.Initialize values β0, β1…, βn with some value. In this case we will initialize with 0.
Iteratively update,

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$$\beta_j := \beta_j - \alpha \frac{\partial}{\partial \beta_j} J(\beta)$$

Until it converges.

This is the procedure. Here α is the learning rate. This operation $\frac{\partial}{\partial \beta_j} J(\beta)$ means we are finding partial derivate of cost with respect to each βj. This is called Gradient.

We are changing the values of βj in a direction in which it reduces our cost function. And Gradient gives the direction in which we want to move. Finally, we will reach the minima of our cost function. But we don't want to change values of βj drastically, because we might miss the minima. That's why we need learning rate.

The illustrated graph represents gradient descent method.

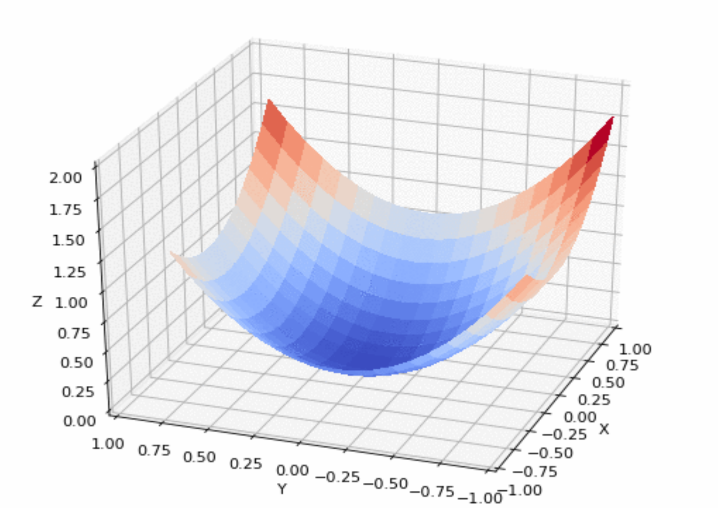

Fig. 3. Graph of gradient descent

After we apply the mathematics.Hence, βj becomes,

$$\beta_j := \beta_j - \alpha \frac{1}{m} \sum_{i=1}^{m} (h_\beta(x^{(i)}) - y^{(i)}) x_j^{(i)}$$

We iteratively change values of βj according to above equation. This particular method is called Batch Gradient Descent.

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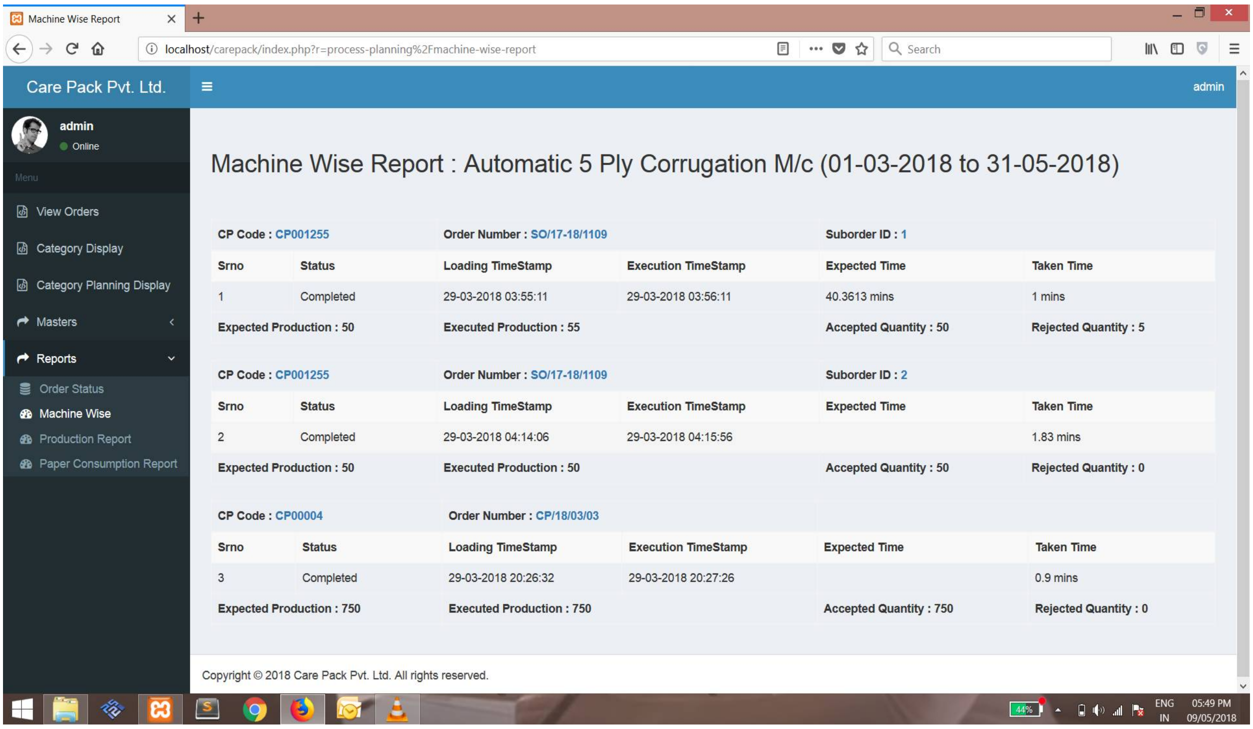
V. Simulation Results



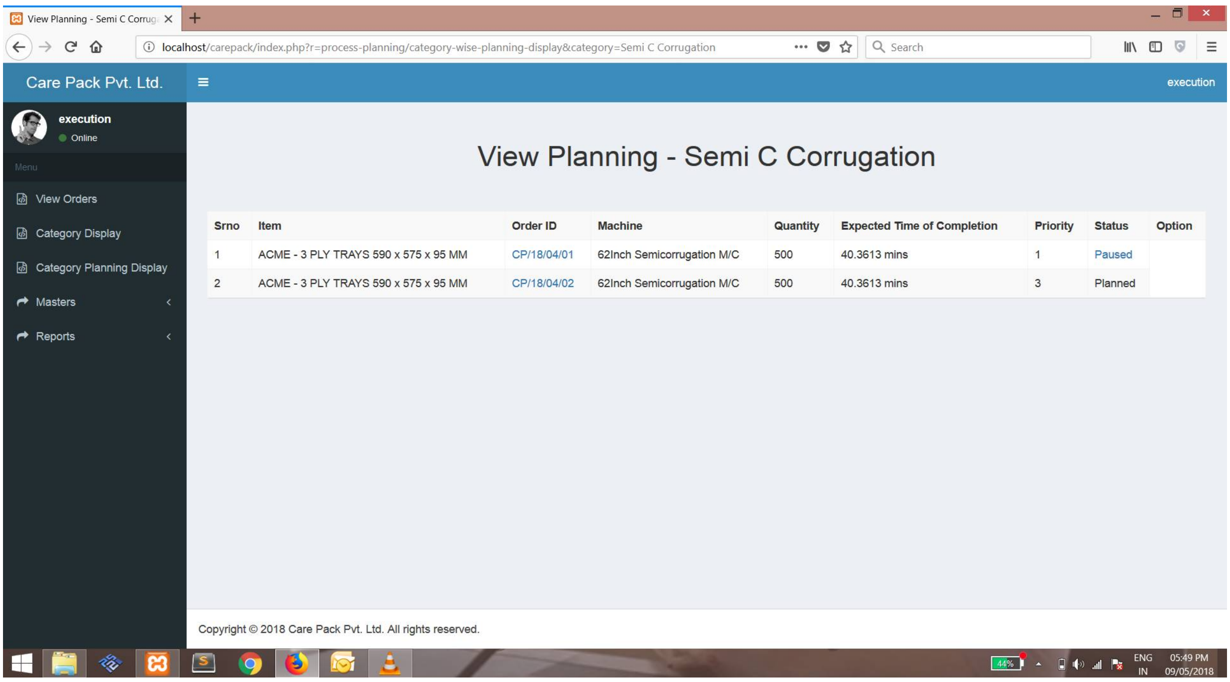


Fig. 4. Results

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VI. CONCLUSION AND FUTURE WORK

This system helps the manufacturing company to plan their production beforehand.It also helps them to minimize their cost of production by giving them the appropriate flow of the production cycle. The real time monitoring of machine can be used to prevent for untimely failure and breakdown of the machines. Automation is a critical aspect of a production based company i.e. production planning. Automated and intelligent planning gives edge over other companies to use the workforce effectively thereby increasing productivity. Monitoring the production conditions so as to ensure the quality of the product remains intact. Similar system with suitable changes can be implemented into various manufacturing industries for better management, analysis and planning.

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