iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 7 Issue: V Month of publication: May 2019

DOI: https://doi.org/10.22214/ijraset.2019.5145

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue V, May 2019- Available at www.ijraset.com

Analytics for Manufacturing Decisions in Supply Chain Management

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Abstract: This paper is a theoretical analysis, opening with the introduction where the background, problem of the research, purpose of the research, objective of the research, expected outcomes, relevance and impact is described. Manufacturing decisions in supply chain management is very crucial for an organization in order to make right decisions regarding manufacturing and inventory management, as the market situation, organization supply chains face today, differs a lot from the situation years ago.

This paper presents a forecasting method which is modelled by artificial intelligence approaches using multilayer perceptron neural network and regression techniques. The effectiveness of the proposed approach to the demand forecasting issue is demonstrated using real-world data from a company which is active in industrial product manufacturing in Pune.

Keywords: Machine Learning, Multilayer Perceptron, Regression techniques, Moving Average Model.

I. INTRODUCTION

Regional collaboration and international sharing of products is the economical driving factor of modern world. Therefore, new relations between sectors and regions are created, and industrial production, as well as strategic decision making becomes increasingly global. Because of search for new resources outside of national borders and intensified competition, companies are forced to look for new realization markets, cheap resources and manpower.

Demand and sales forecasting is one of the most vital functions of manufacturers, distributors and trading firms. Keeping demand and supply in balance, they reduce excess and shortage of inventories and improve profitability. When the producer aims to fulfil the overestimated demand, excess production results in extra stock keeping which ties up excess inventory. On the other hand, underestimated demand causes unfulfilled orders, lost sales opportunities and reduces service levels. Both scenarios lead to inefficient supply chain management . Thus, the accurate demand forecast is a real challenge for participant in supply chain management. Historic data is a key tool to support the individual and organizational decision making in supply chain management(SCM). In short the proposed system will predict the product gross profit, also recommend the future manufacturing product and their quantity, considering the company's historic data. This will help in making product manufacturing schedule depending on analysed result. Forecasting is an integral part of supply chain management. Traditional forecasting methods suffer from serious limitations which affect the forecasting accuracy. Artificial neural network (ANN) algorithms have been found to be useful techniques for demand forecasting due to their ability to accommodate non- linear data, to capture subtle functional relationships among empirical data, even where the underlying relationships are unknown or hard to describe.

Section 2 presents critical view of the past work done in SCM and also on various approaches used in them. The techniques and methodology used in proposed system. Section 3 describes the feedback and expert guidance for proposed system and also, the modelling of System. After observing the behaviour, results are described inSection 4.States the algorithm used to implement the proposed system. Section 5 shows the result of the implemented work as per the details metioned in this paper, by displaying the screenshots of the same. Section 6 mentions important applications and future directions of work.. Section 7concludes this paper by giving the summary of this system.

II. RELATED WORK

Demand and sales forecasting is one of the most important functions of manufacturers, distributors, and trading firms. Keeping demand and supply in balance, they reduce excess and shortage of inventories and improve profitability. When the producer aims to fulfil the overestimated demand, excess production results in extra stock keeping which ties up excess inventory. On the other hand, underestimated demand causes unfulfilled orders, lost sales foregone opportunities and reduce service levels. Both scenarios lead to inefficient supply chain. Thus, the accurate demand forecast is a real challenge for participant in supply chain.(A.A. Syntetos et al., 2010)

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Demand forecasting has attracted the attention of many research works. Many prior studies have been based on the prediction of customer demand based on time series models such as moving-average, exponential smoothing, and the Box-Jenkins method, and casual models, such as regression and econometric models [1]. There is an extensive body of literature on sales forecasting in industries such as textiles and clothing fashion (Y.Fan et al., 2011), (Z.L. Sun et al.,2008) ,books (K. Tanaka et al., 2010),and electronics (P.C. Chang et al.,2013). However, very few studies center on demand forecasting in industrial valve sector which is characterized by the combination of standard products manufactures and make to order industries.

The current economic climate pushes businesses to be more competitive and thus leads to re-evaluating their supply chain and supplier strategies. This competitiveness requires organisations to be more effective, efficient and productive with lower margin for error. It is also pushing companies to work more strategically with their supply chains and partners [2]. Hence strategic supply partnership is becoming more critical and will determine the sustainability and competitiveness of companies in the future [3]. Flexible supply policies also help companies adapt quickly to changing market conditions and become more competitive [4]. Competitiveness takes many forms, and this paper focuses on the parts of the supply chain activities that inter-relate with suppliers and manufacturers in their operational aspects. Term "supply chain" was used for the first time in the beginning of 9th decade of XX century, when Oliver and Webber (1982) proposed that this notion would be use to describe new science field which was yet in development [5]. Its creation was encouraged by the changes of common strategic business trends, where the focus was shifted from satisfying of inner interests of company to achieving greater good through more efficient structure of organization, which could create better value for clients and shareholders (Christopher and Peck, 2003). Because of constantly changing business processes in 10th decade of XX it was aimed to increase the flow of multifunctional organizational processes by integrating elements of logistics, operation control and marketing (Christopher and Peck, 2003). The objective was to increase the efficiency of all flows that include movement of production from production of raw materials to final market of consumer of developed goods. And the development of information technologies facilitated this task by giving the ability to achieve better efficiency of supply chain and to get information about market changes and emerging consumer needs, more efficiently. Than it was started to look at chain phenomenon form the perspective of market factors, changes of consumer requirements and integration of separate processes and informational technologies. Supply chain – is a network of companies, whichparticipatein processes of distribution of goods, services, financial resources and informational flows between initial supplier and final consumer (Christopher, 1992; Mentzer et al., 2001; Lambert et al., 2005).

III. PROPOSED METHODOLOGY

Analysis of decision in supply chain management for product manufacturing is very essential which helps to predict the future profit to the company. In the proposed system is implemented to overcome the manufacturingissues faced by the company by considering the companies historical data and performing analysis on the data and applying the linear regression predicting the future. The proposed system will give result date wise, month wise, year wise and also recommend the product and quantity. It also makes schedule for manufacturing depending on the analysis result. In this system we are using the Multi-layer perceptron linear regression algorithm for predicting future product.The overall working of the system is as follows:

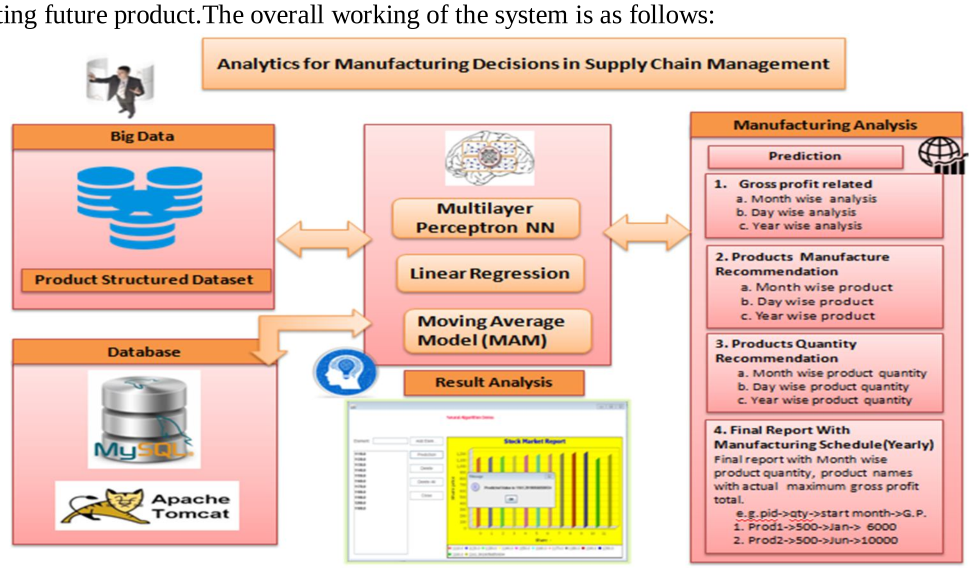

Figure 1: Architecture of Proposed System

A. *Gather Historical Data*

Historical data gathered from the database of the manufacturing company since the last 10-20 years. This data contains all company information like their product manufacturing process, previous sale history, company turnover etc.

B. Preprocessing

Preprocessed historical data used for further data analysis.

C. *Manufacturing Analysis*

Linear regression and multilayer perceptron NN are used for analyzing the all historical data and then predict the future data. Data analysis done on following points,

1) *Gross Profit:* Get the product gross profit from historical data and analyze them. It predicts the future gross profit for that product.
2) *Manufacturing Product:* Analyze the historical manufactured product data. This data contains the client demanded products and actual manufactured product and final sold products.
3) *Manufacturing Quantity:* Historical manufacturing product quantity and product soled quantity analysis help to predict future manufacturing quantity.

D. *Analysis Result*

According to the predicted data, the system will gives the final outcome. It gives the comparison graph based on following points,

1) *Day-wise:* Day-wise analysis result helps to predict the day-wise product gross profit. It also recommends the day-wise manufacturing product and product quantity.
2) *Month-wise:* This analysis result helps to predict the month-wise product gross profit. It also recommends the month-wise manufacturing product and product quantity.
3) *Year-wise:* This analysis result helps to predict the year-wise product gross profit. It also recommends the year-wise manufacturing product and product quantity.
4) *Manufacturing Schedule:* Depending on the predicted product gross profit and recommended manufacturing product and their quantity system will generate the final product manufacturing schedule.

E. *Product Manufacturing Report*

Depending on the data analysis results the system will give the final product manufacturing report.

IV. ALGORITHMS USED

A. *Multi-Layer Perceptron*

A multilayer perceptron (MLP) is a feed forward artificial neural network model that maps sets of input data onto a set of appropriate outputs. An MLP consists of multiple layers of nodes in a directed graph, with each layer fully connected to the next one. Except for the input nodes, each node is a neuron (or processing element) with a nonlinear activation function. MLP utilizes a supervised learning technique called backpropagation for training the network. MLP is a modification of the standard linear perceptron and can distinguish data that are not linearly separable.

1) *Activation Function*

a) If a multilayer perceptron has a linear activation function in all neurons, that is, a linear function that maps the weighted inputs to the output of each neuron, then it is easily proved with linear algebra that any number of layers can be reduced to the standard two-layer input-output model.

b) $$y(v_i) = \tanh(v_i) \quad \text{and} \quad y(v_i) = (1 + e^{-v_i})^{-1},$$

c) In which the former function is a hyperbolic tangent which ranges from -1 to 1, and the latter, the logistic function, is similar in shape but ranges from 0 to 1. Here y_i is the output of the ith node (neuron) and v_i is the weighted sum of the input synapses.

2) *Layers*

a) The multilayer perceptron consists of three or more layers (an input and an output layer with one or more *hidden layers*) of nonlinearly-activating nodes and is thus considered a deep neural network

3) *Learning Through Back Propagation*

a) Learning occurs in the perceptron by changing connection weights after each piece of data is processed, based on the amount of error in the output compared to the expected result. This is an example of supervised learning and is carried out through back propagation, a generalization of the least mean squares algorithm in the linear perceptron.

b) We represent the error in the output node j in the n^{th} data point by $e_j(n) = d_j(n) - y_j(n)$, where d is the target value and y is the value produced by the perceptron.

c) We then make corrections to the weights of the nodes based on those corrections which minimize the error in the entire output, given by

$$\mathcal{E}(n) = \frac{1}{2}\sum_j e_j^2(n).$$

Using gradient descent, we find our change in each weight to be

$$\Delta w_{ji}(n) = -\eta \frac{\partial \mathcal{E}(n)}{\partial v_j(n)} y_i(n)$$

Where, y_i is the output of the previous neuron and η is the *learning rate*.

d) The derivative to be calculated depends on the induced local field v_j, which itself varies. It is easy to prove that for an output node this derivative can be simplified to

$$-\frac{\partial \mathcal{E}(n)}{\partial v_j(n)} = e_j(n)\phi'(v_j(n))$$

Where, ϕ' is the derivative of the activation function described above.

B. *Linear Regression*

Linear regression is a statistical method that allows us to summarize and study relationships between two continuous variables. Linear regression is a linear approach for modeling the relationship between a scalar dependent variable y and one or more explanatory variables denoted X. The case of one explanatory variable is called simple linear regression. For more than one explanatory variable, the process is called multiple linear regressions. In linear regression, the relationships are modeled using linear predictor functions whose unknown model parameters are estimated from the data. Such models are called linear models. The least squares regression line for the set of n data points is given by

$$y = ax + b$$

Where, a and b are given by

$$\hat{\beta} = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sum_{i=1}^{n}(x_i - \bar{x})^2} = \frac{\sum_{i=1}^{n} x_i y_i - \frac{1}{n}\sum_{i=1}^{n} x_i \sum_{j=1}^{n} y_j}{\sum_{i=1}^{n}(x_i^2) - \frac{1}{n}(\sum_{i=1}^{n} x_i)^2}$$

$$= \frac{\overline{xy} - \bar{x}\bar{y}}{\overline{x^2} - \bar{x}^2} = \frac{\operatorname{Cov}[x, y]}{\operatorname{Var}[x]} = r_{xy}\frac{s_y}{s_x},$$

$$\hat{\alpha} = \bar{y} - \hat{\beta}\,\bar{x},$$

C. *Moving Average Model (MAM)*

A moving average is a technique to get an overall idea of the trends in a data set; it is an average of any subset of numbers. The moving average is very useful for forecasting long-term trends. You can calculate it for any period of time. For example, if you have sales data for a twenty-year period, you can calculate a five-year moving average, a four-year moving average, a three-year moving average and so on. Stock market analysts will often use a 50 or 200 day moving average to help them see trends in the stock market and (hopefully) forecast where the stocks are headed.

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The planned method first guess the average travel speed to the immediate downstream route segments, denoted by i, based an average speed estimate updated dynamically as follows:

$$v_i = \frac{av_r + bv_{ai}}{a+b}$$

v_i = predicted speed of route segment i (to the immediate downstream route segments),
v_r = current speed of bus derived from GPS data,
v_{ai} = historical average speed of route segment i in current time period, and
a,b = weighting factors defined in Equation

$$a = S_{if} \qquad b = S_{ib}$$

V. RESULT SCREENSHOTS

First select the product to get the analysis for particular product. Byselecting the algorithm for the analysis. With the help of this system user can also select the type of analysis i.e. if want day wise, Month wise or year wise analysis.

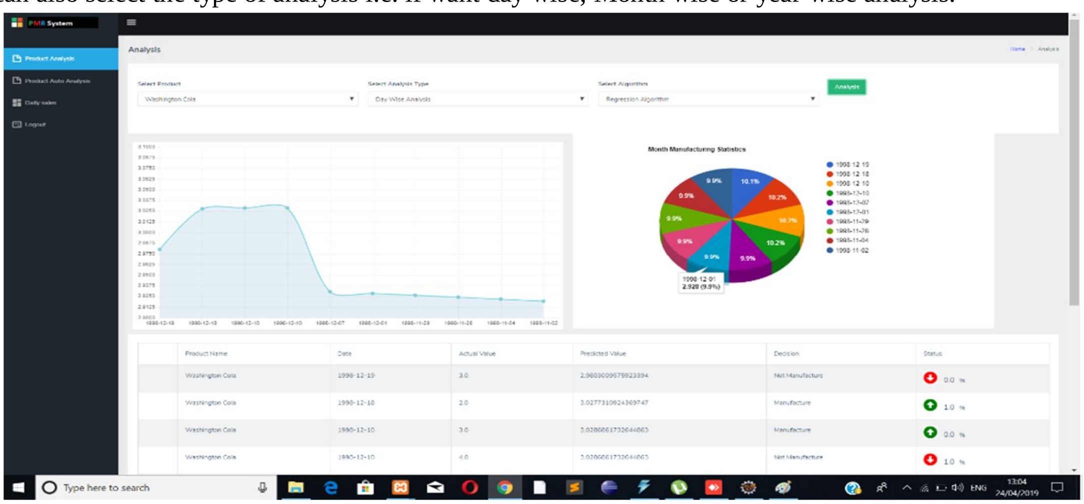

Figure 2:Day Wise Analysis Using Regression Algorithm

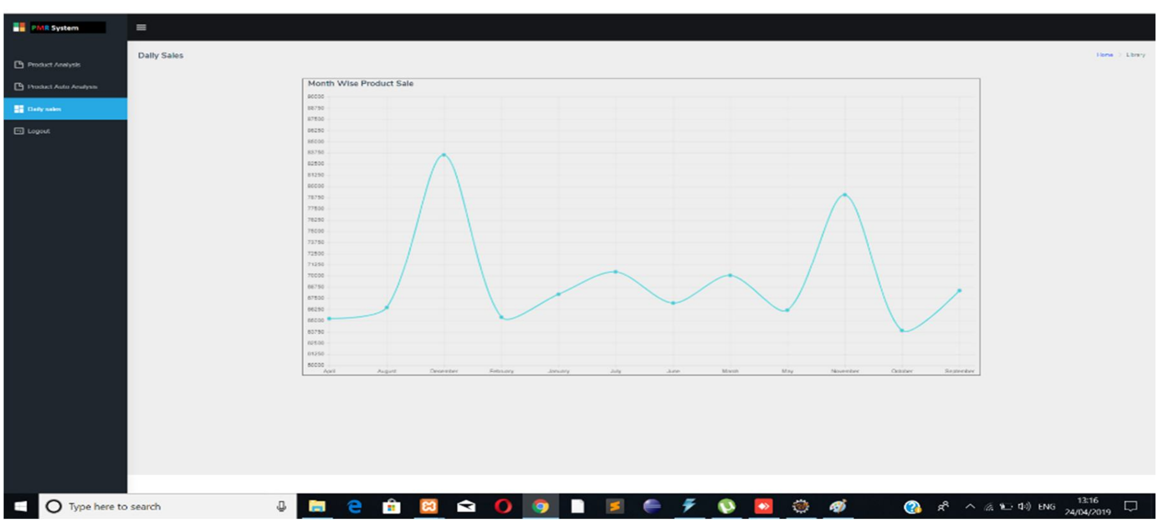

Figure 3:Month wise Product Sale

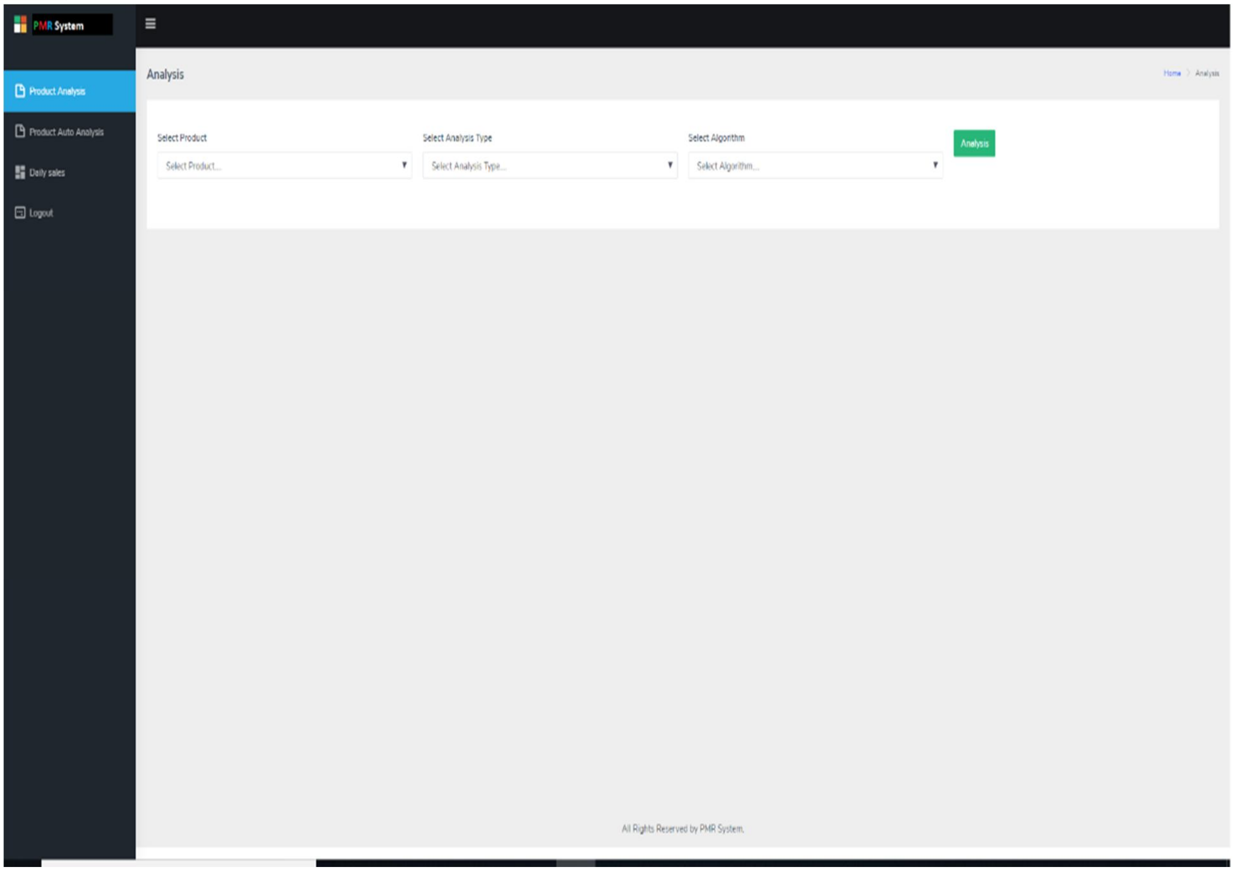

Figure4:Product Analysis

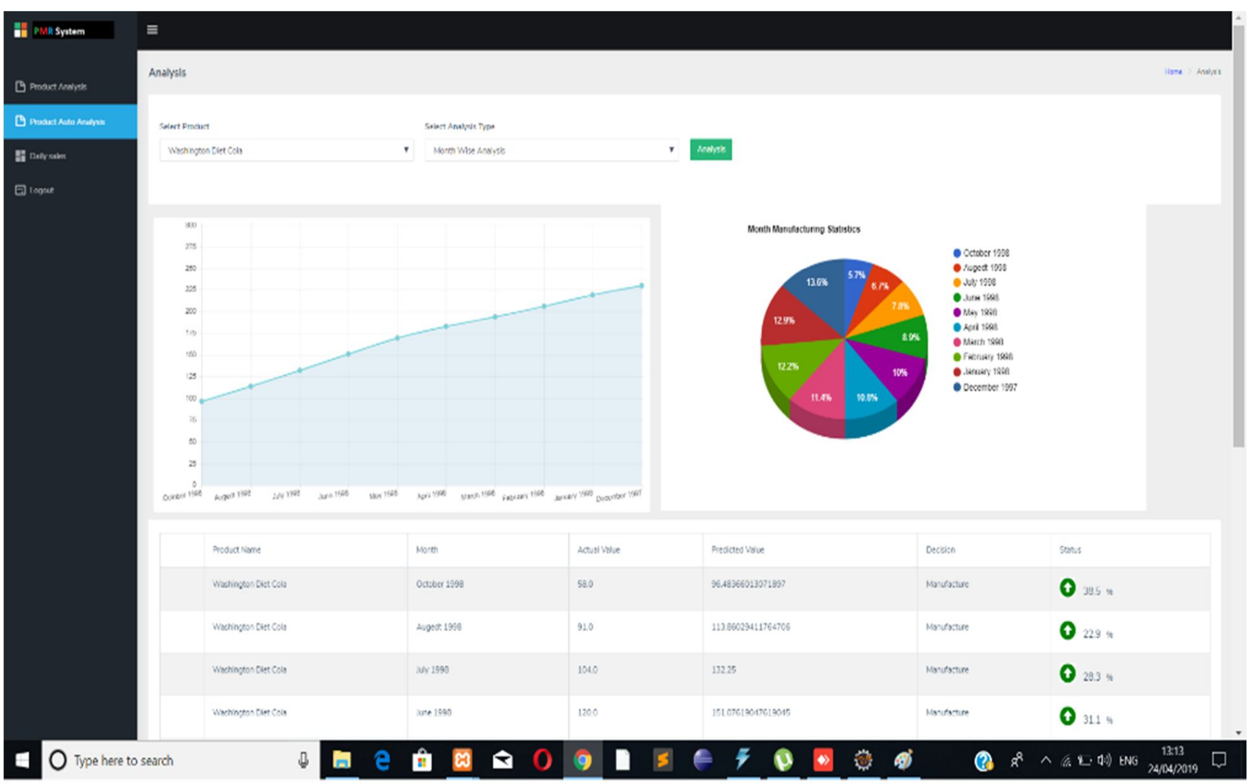

Figure 5: Month wise Product Analysis

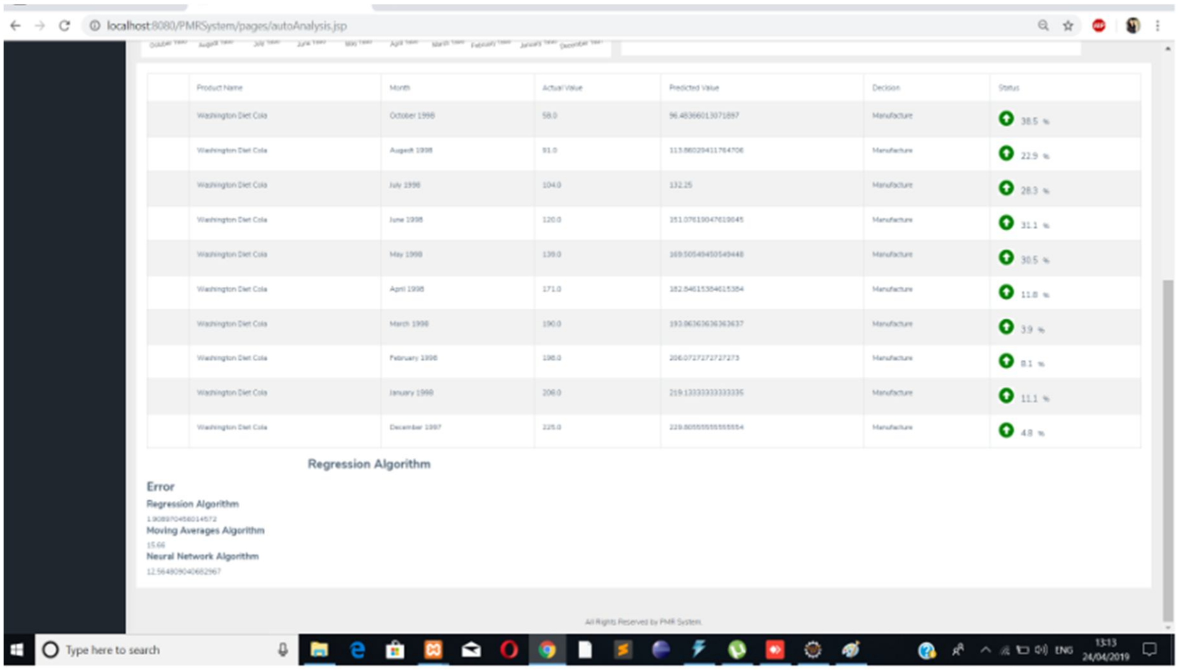

Figure 6

VI. APPLICATIONS

A. Used in manufacturing companies for predicting future trade scenario.
B. Product Flow and Delivery.
C. Collaboration with Suppliers and Partners

VII. CONCLUSION

The objective of this research is to study the effectiveness of forecasting the demand signals in supply chain management and increase its accuracy by using various approaches. This system can help in decision making for a company and increase its profit. The system will give manufacturing analysis based on the historical data stored in the database and predict the future. The proposed system can be considered as a successful decision support tool in forecasting customer demands as it will generate analysis result date wise, month wise, year wise and also recommend the product quantity system will generate the final product manufacturing schedule. It will also generate a product manufacturing result depending on the data analysis and gives management for product manufacturing. Future research can explore the possibility of using other approaches to increase the accuracy for huge amount of data.

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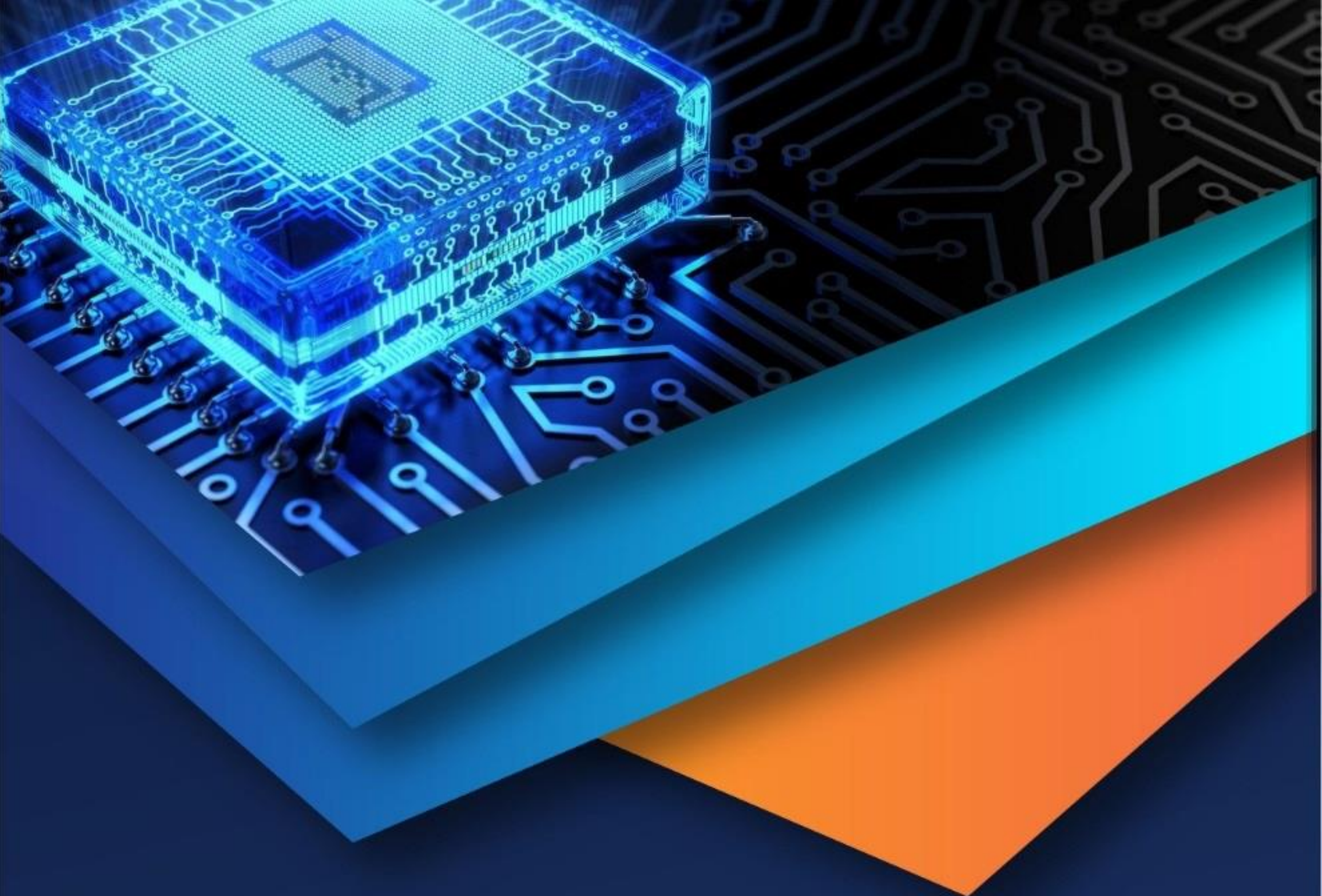

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