

Sales Forecasting Using Linear Regression

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Abstract- In many countries, the goods supplying companies have a hard job trying to make its operations planning. The difficulty is created by a combination of handling a large number of products and changeable consumption patterns of each customer. To simplify the operation planning task of those companies, a simplified system needs to be envisaged and programmed. This system was written in PHP language (for web development dynamic content) and HTML (for making Web pages) which runs on different operating systems. This program applies five quantitative sales forecasting techniques for each marketable product, with continuous assessment, in order to select case by case, the monthly more accurate prediction method.

Keywords: Sales forecast, linear regression, application

I. INTRODUCTION

Effective planning, in short and long term, depends on demand forecasts for the company products (Heizer, J. 2009). Good forecasts are crucial to all business aspects: Demand forecast is the only useful data until the actual demand is known. Therefore, demand forecasts guide decisions in many areas: human resources, capacity management and supply chain. Forecasting is fundamental in any planning effort (Chase, R. (2014)). In the short term, forecast is needed to predict the material, products, services or other resources to respond to changes in demand. Forecasts allow adjusting schedules and varying labor and materials. In the long run, it is required to predict the basis for strategic changes, such as the development of new markets, new products or services and expand or build new facilities. Sales and operations planning is a process that helps to provide better customer service, handling of lower inventories, offer shorter delivery

time to customers, stabilize production rates and facilitate management business.

It does not matter that, owing to changing markets, the chemicals supplying enterprises have troubles with operations scheduling and inventories management; they are a fundamental component in the national economy. The chemicals supplying enterprises demands are highly variable in volume and presentation; their customers vary from a small hardware store, up to an auto assembler factory, passing through: pharmaceutical, chemical, petrochemical and polymer companies, paints and varnishes manufacturers, etc. In some companies, they handled up to 500 different materials and have up to 1000 clients; all of this complicates their operations planning. Because of the above chemicals supplying enterprises problems, a system to forecast their sales with the best possible accuracy is proposed. The system, (algorithm and software) for the yearly or monthly sales prediction, calculates a possible sales number for each product using five techniques, evaluates the error of each of them and selects the lowest error technique; from which the sales forecast for each product is proposed.

The goal is to make effective plans in order to properly satisfy the customer demands. According to Thompson, (2014) the key to a most efficient Supply Chain is forecast, which very much depends on people, process, and technology. In order to gain participation from Sales, we need to

- 1) Educate Sales people so that they understand why forecasting is essential,
- 2) Developing a well-structured forecasting process,
- 3) Clearly define roles and responsibilities, and
- 4) Make access to systems easy to use to facilitate their participation.

A. Statement of the Problem

This project was undertaken to eliminate some problems with conventional sales forecasting management system. Where accountants has to calculate using a specific sales model formula in forecasting on a regular basis. Using these conventional method pose lots of constraint on sales forecasting as it takes lot of time forecasting using which ever model is adopted by the manager or accountant or financial adviser.

B. Aims And Objective Of Project

In view of the problems mentioned above, this project is aimed at implementing a sales forecasting system using linear regression model to:

1. Manage forecast sales.
2. Automate customer, product, and supplier management on the system.
3. Manage system access and roles on the system.
4. Manage every users of the system.

II. LITERATURE REVIEW

Forecasting, according to Everett et al. (2000), is to use past data to determine future events. Forecasts are often used to predict consumer demand for products or services, although they can predict a wide range of future events that could potentially influence the success way. Forecasting is the art and science of predicting future events. It may involve the management of historical data to project future, through some kind of mathematical model. It can be a subjective or intuitive prediction of future, or a combination of both, i.e., a mathematical model adjusted for the judgment of an administrator. Forecasting, according to Corres, G. (2009), involves the estimation and analysis of future demand for a particular product, component or service, through different forecasting techniques. The forecast of future demand is central to any operations planning. At the organizational level, the sales forecast is an essential input for any decision in many functional areas: sales, production, purchasing, finance and accounting. The forecasts are also needed in the distribution and supplying plans. The importance of a sales forecast with a manageable error margin is critical to the efficient management of inventories. This was in large part recognized by several authors (Chu & Zhang, 2003).

A. Basic Principles of Forecasting

Anderson et al. (2011), give the next three basic principles for forecasting:

- Forecasts are not perfect, have an error margin.
- Most of the forecast techniques assume the existence of some stability in the system.
- Forecasts on aggregate products are more stable.

B. Horizons of The Forecast

Usually, a forecast is classified by the covered future time horizon. The time horizon is classified into three categories:

1. Short-Term Forecast: It has an extension of time up to one year, but usually less than three months. It is used to plan purchasing, scheduling work, determining levels of labor, assign work, and decide production levels.
2. Medium-term Forecast: Frequently a medium-term forecast, or intermediate term, has an area of between three months and three years. It is used to plan sales, production, budget and cash flow as well as to analyze different operating plans.
3. Long-term Forecast. Usually its extension is 3 years or more. These forecasts are used to plan the manufacture of new products, capital expenditures, location or expansion of facilities, and research and development.

The medium and long term forecasts are distinguished from short-term ones by three characteristics: First, medium and long-term forecasts handle general aspects and support to administrative decisions concerning the products, plants and processes planning. The implementation of some decisions about facilities, may take 5-8 years since its conception until its termination. Second, the short-term forecast usually employs different methodologies, than the longer ones. The mathematical techniques commonly used in short-term forecasts are: moving averages, exponential smoothing and trend extrapolation. The less quantitative methods are useful for taking decisions such as those related with the introduction of new products in the near future. Finally, short-term forecasts tend to be more accurate than long-term ones. Factors influencing demand change daily. Therefore, as the time horizon lengthens, the forecast accuracy decreases. So it is necessary to state that

sales forecasts should be used regularly to maintain its value and integrity. After each period of sales, forecasts should be reviewed and updated.

C. Forecasting Techniques

Qualitative Techniques

Expert Opinion Panel It is based on the intuition of one or more experienced executives regarding products stable demand. Its disadvantage is that it is influenced by recent events. **Delphi Method** Experts make the global and/or product by product sales predictions. A facilitator provides the experts with the average of the sales forecast and the reasons for their judgments. The experts revise their previous estimates and make new ones. The procedure is repeated until the achievement of a reasonable consensus. It is a highly accurate forecasting method.

i. **Sales Force Composition**

A technique used to project the future demand for a good or service based on the total amount that each salesperson anticipates being able to sell in their region.

ii. **Market Survey**

The study of the spending characteristics and purchasing power of the consumer

D. Techniques for Time Series

Historical data from company sales is used to discover trends in seasonal, cyclical and random or erratic type. It is an effective method to produce reasonably stable demand.

i. **Simple moving average (SMA).** This technique involves calculating the average of the n most recent values and uses it as a forecast for the next period. By moving averages it is possible to determine if there is a seasonal factor within the time interval under consideration. Sum of (formula) previous values n

ii. **Weighted moving average (WMA).** This technique involves calculating the average of the n most recent values giving a different "weight" in the forecast for each of the values involved. (The formula used is in the material 6876-22140-1-SM).

iii. **Exponential moving average (EMA).** This is a type of moving average, where the forecast for the next period is based on all previous data. The most recent data has a greater weight in the forecast. The weighting for each older datum decreases exponentially, never reaching zero. (Formula)

iv. **Double Exponential smoothing with adjustable trend.** This is a type of smoothing that includes a special coefficient to detect a trend behavior and a coefficient for the overall behavior of the series. (Formula).

v. **Trend Projection** is used to analyze the data sets and project a linear trend in the future. The least squares method is used to find the best trend line with time as the independent variable. $Y = b_0 + b_1 X$ Where: Y = the predicted value b_1 = the slope of the trend line b_0 = intercept X = time of the forecast

vi. **Series decomposition** is used to analyze the data series based on the behavior of its components. There are two basic models to describe the data of a time series: Multiplicative and additive model.

Multiplicative model

$Y_i = (T_i)(S_i)(I_i)$ Additive model $Y_i = T_i + S_i + I_i$ Where: T_i is the linear trend rate S_i is the index of the component seasonal I_i is the index of the irregular component

E. Causal Techniques

i. **Simple linear regression.** This is a casual approach that seeks to relate and explain the variation in the data of an indicator, as a result of a variation in a particular cause. Applied and analyzed along with the correlation coefficient and determination coefficient to interpret the explanation. The model is: $Y = b_0 + b_1 X$ where: b_0 is the intercept b_1 is the slope of the linear relationship b_0, b_1 are obtained by the minimum squares method.

ii. **Multiple Linear Regressions.** Multiple linear regression attempts to model the relationship between two or more explanatory variables and a response variable by fitting a linear equation to observed data.

Sources and Type of Error in the Forecast The present system assumes that a proper screening and correction of the data and the data errors was already made. The software determines the forecast techniques behavior and their errors, by the following calculations: Forecast error = actual value - predicted value QME: Quadratic mean error

MAPE: Medium absolute percentage error

MAD: mean absolute deviation

Most common error measurements $QME = \Sigma$

(forecast error) $2 / n$ MAD = $\Sigma | \text{forecast error} | / n$
 MAPE = $[\Sigma | \text{forecast error} | / \text{actual value}] / n$
 Control signal (tracking) Tracking = $\Sigma (\text{forecast error}) / \text{MAD}$.

III. SYSTEM DESIGN/DESIGN METHODOLOGY

In designing a new system, a review of the clerical and other manual methods was compared with the computer-based system and the following were taken into consideration;

1. To design a system that will be to manage sales forecast for the coming month from the previous sales.
2. To design a system that will manage daily sales of the company.
3. To design a system that is capable of updating all records.
4. To design a system that is user friendly.

A. Objectives of The New System

The objective of the new system includes;

- Provision of accurate sales forecast on a timely basis
- To ensure less tedious work for the staff.
- To prevent fraudulent acts from the users (most especially the cashier).

- Provision of adequate sales report on a daily, weekly and yearly basis.

B. Scope of The Design

The scope of the design will cover operation of Mosbe mini market and this is achieved through the following;

- Assigning unique number to each staff
- Creating a table, where the product name, the product code, unit price of selling each product and the balance quantity of each product is kept for easy updating.
- Each product code is made as a primary key in the table to avoid duplication.
- Updating of the transaction, the stock and the item simultaneously.

C. Output Design of the New System

In designing the new system, it is imperative to first design what the expected output will look like, so that when coding the program, one can already have the knowledge of the task to be accomplished. Since the input influences the output requirement. The output design of this project will take the format below;

S/n	Product Name	Product code	Available Quantity	Unit price	Forecast for next month
1	Lipton Yellow label	M4rt34	67	200	45

D. Input Design Of The New System

The following are the inputs to the proposed system

- Product forecast form
- User login form
- Admin login Form
- Staff registration form

Identify Program Module to Be Developed

The modules of the program to be developed are listed below:

- Home page webpage
- Category web page
- User catalogue web page
- Admin web page
- Admin transactions history web page
- All product page
- About us page
- Frequently ask question page
- Contact Us

Visual Table Of Content (VTOC Chart)

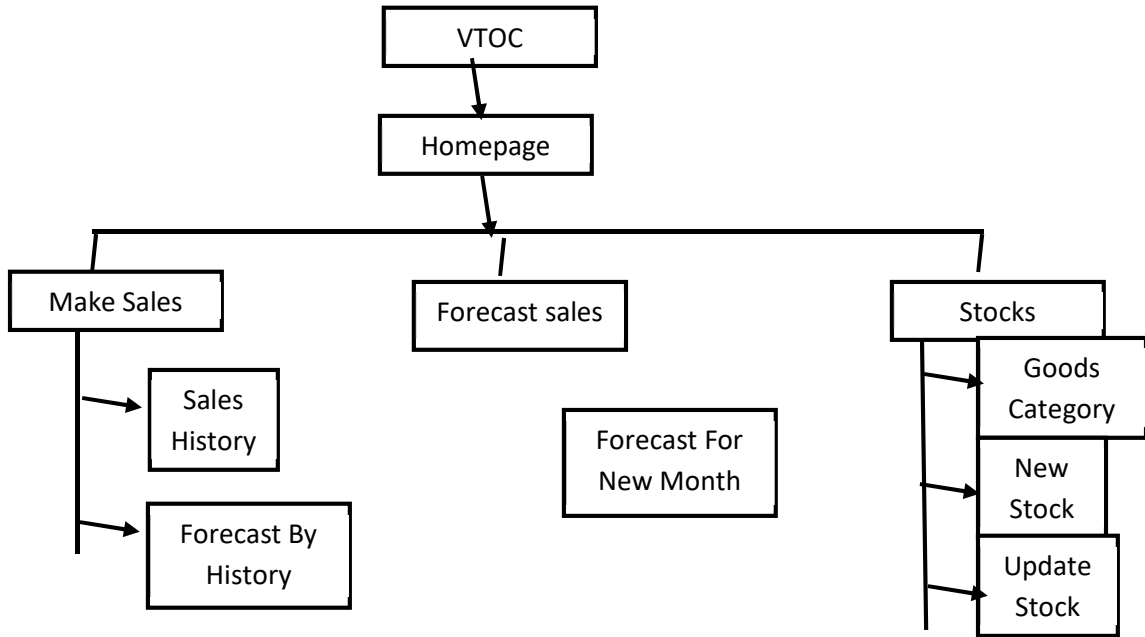


Figure 3.1: Visual Table of Content (VTOC Chart)

Hierarchy Input, Process, Output Chart (HIPO Chart)

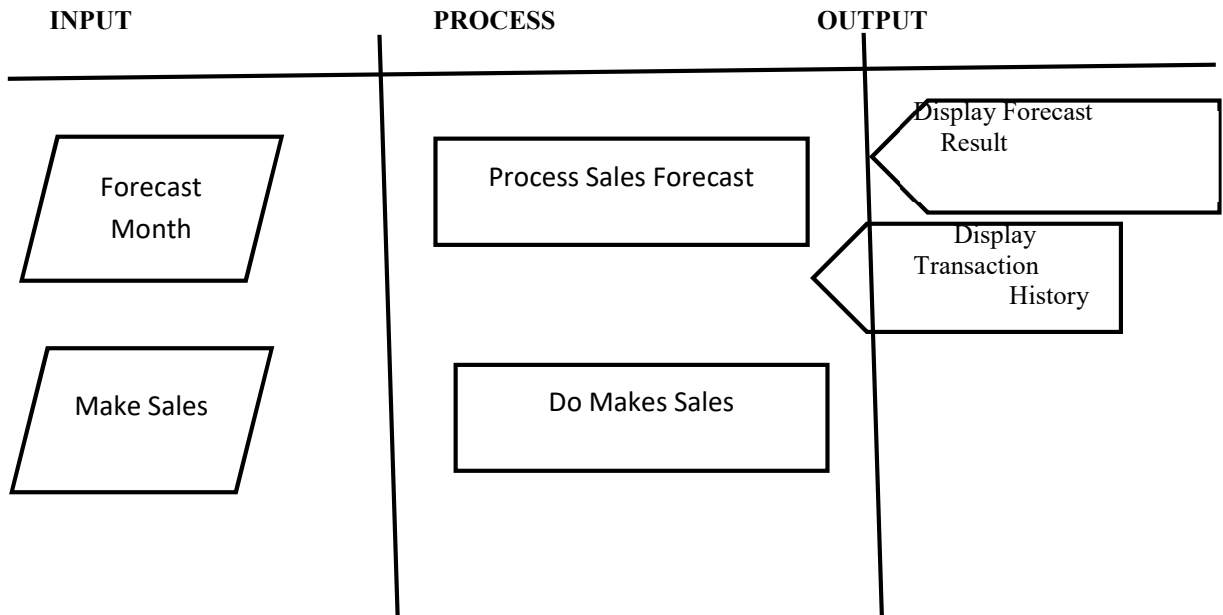


Figure 3.2: Hierarchy input, process, output chart

IV. DESIGN AND IMPLEMENTATION

The development of a system begins after the design of the input and the specification of the output as shown in chapter four. The system development which includes the sequence of each parts of the program modules.

A. Programming Language Used

A computer program is a set of coded instructions to be inputted into the computer system to solve a specific task. The concerned task in this research is to develop an error free program that will forecast the sales of a particular product for the next month. And for this project; the programming language chosen is PHP.

B. Environment Used For Development

The environment used in the development of this software is Netbeans IDE. The environment entails graphic elements to make sure the home page is attractive.

C. System Testing

This has to do with testing of the new system with various input data to check if it is correct. When this is done, it is evaluated using vendor rating system or benchmark. The vendor rating system has to do with the rating done by the analyst based on the set of operations his system could perform. This may be deceiving at times. On the other hand, benchmark is the grading cone by the user or customer itself based on what he/she expects the new system to perform. But sure, when coding the program in, different sorts of errors were encountered such as the syntax error.

D. System Implementation

System implementation follows the approval of the system proposals and its objectives thus it is to arrive at a satisfactory, implemental, completed, evaluated and function of the automated system. This implementation is represented to help the users of the system and all those that don't have prior knowledge of the computer system to effectively and efficiently operate and achieve the system's goal. Also it has to do with the process of changing from the old system to the newly designed system.

E. SYSTEM REQUIREMENTS

The system for running a computerized sales forecasting system involves both the hardware and software parameter alongside the human ware (people)

Hardware Requirements

- Pentium III processor (minimum)
- 256MB – 4GB RAM/memory space
- 10GB Hard disk space (minimum)
- SVGA color monitor
- Standard keyboard
- Mouse
- CD ROM drive or DVD drive
- A Stabilizer
- 1500v uninterrupted power supply (UPS)

Software Requirements

- Operating system: Window Xp professional edition, windows vista or window 7
- Internet service application such as Internet explorer 6.0 or Mozilla Firefox
- SQ express edition
- Notepad accessory

System Interface

Where the username login in with the username and password as shown in figure 4.1 This shows records for the stock available and the price of each product

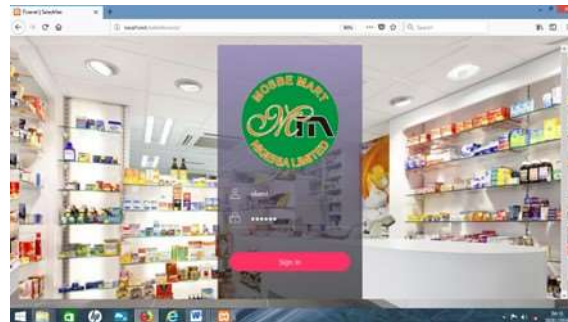


Figure 4.1: Stock available and price

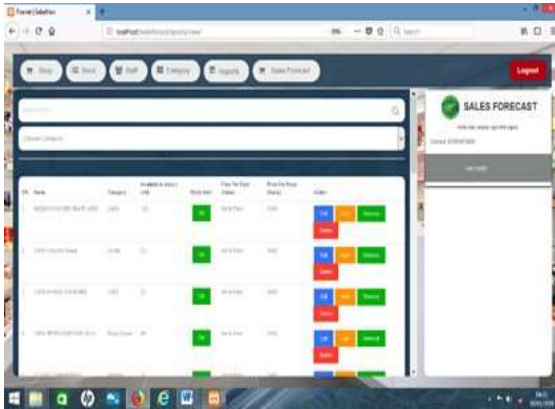


Figure 4.2: Make sales



Figure 4.5: Sales forecast

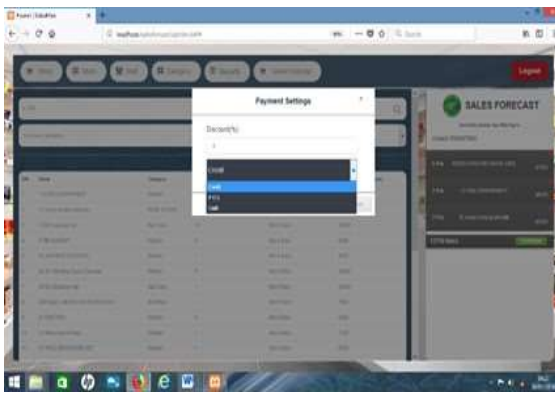


Figure 4.3: Payment settings



Figure 4.6: Forecast selection

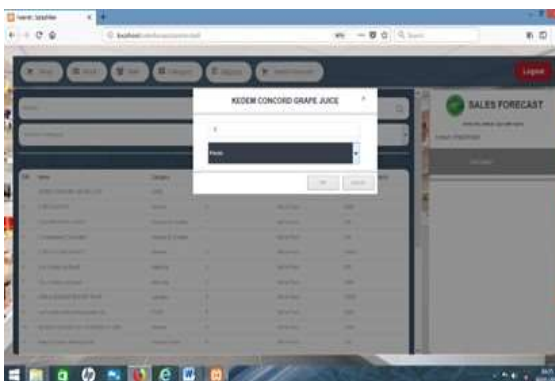


Figure 4.4: Payment receipt

V. CONCLUSION AND RECOMMENDATION

A. Conclusion

The present work has successfully implemented sales forecast using linear regression model. This sales forecasting system is comparative accurate to accomplish the function of using historical data and real data to do a variety of prediction methods. Combining the advantages of the proposed method, synthesis considering various kinds of factors that affect the sales forecast, the system generates all kinds of data that companies needed, and provide important support for business managers to make decisions.

B. Recommendation

Forecasting, according to Everett et al. (2000), is to use past data to determine future events. Forecasts are often used to predict consumer demand for products or services, although they can predict a wide range of future events that could potentially influence the success way. Forecasting is the art and science of predicting future events. It may involve the management of historical data to project future, through some kind of mathematical model. It can be a subjective or intuitive prediction of future, or a combination of both, i.e., a mathematical model adjusted for the judgment of an administrator. Forecasting, according to Corres, G. (2009), involves the estimation and analysis of future demand for a particular product, component or service, through different forecasting techniques. The forecast of future demand is central to any operations planning. At the organizational level, the sales forecast is an essential input for any decision in many functional areas: sales, production, purchasing, finance and accounting. The forecasts are also needed in the distribution and supplying plans. The importance of a sales forecast with a manageable error margin is critical to the efficient management of inventories. Although, the new forecasting system could be expensive, but it is recommended as it enable the company or organisation to meet the customer need and to reduce risk of loss of perishable goods.

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