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Analysis and Forecasting Of the Production Quantity in a Manufacturing Industry Using Historical Data

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----------ABSTRACT----------

This research work focused on the use of forecasting techniques to model and analyze the production of plastic products in Loius carter plastic industry. Production yield data were collected from the company covering a period of three years. The applied forecasting models were used to forecast the results of the future production of the products. The applied models developed using weighted moving average method, winters model and Double exponential smoothing model show that Y1 (10litres bucket) product was to be produced for 13997.6, 15854 and 10206.5 units respectively for the month of January 2014, while for the February 2014, weighted moving average method, winters model and Double exponential smoothing model show that Y1 product was to be produced for 8554.12, 15024.1 and 9791.2 units respectively. These methods were applied on the products for monthly yield of the product types investigated. From the results, the decrease in trend showed a continuous decrease in their future production output on the product Y1. The seasonal influences were analyzed based on months using the production data of the case study company. Time series decomposition analyses were also used to study the seasonality and trend in the five products investigated.

Key Terms: *time series, forecasting, moving average, winters, double exponential, production quantity*

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I. Introduction

Forecasting is the process of making statements about events whose actual outcomes (typically) have not yet been observed. A common place example might be estimation of some variable of interest at some specified future date. Prediction is a similar, but more general term. Both might refer to formal statistical methods employing time series, cross-sectional or longitudinal data, or alternatively to less formal judgmental methods. Usage can differ between areas of application: for example, in hydrology, the terms "forecast" and "forecasting" are sometimes reserved for estimates of values at certain specific future times, while the term "prediction" is used for more general estimates, such as the number of times floods will occur over a long period.

Risk and uncertainty are central to forecasting and prediction; it is generally considered good practice to indicate the degree of uncertainty attaching to forecasts. In any case, the data must be up to date in order for the forecast to be as accurate as possible [1].

Prediction is also known as forecasting. In an effective and efficient business organization, application of good forecasting technique is very important for the successful operations of the business in any organization. It is vital in the control of materials and goods for inventory forecasting and the control of production in the case of production or exchange of activities and services.

The principal goal of forecasting in an organization is to foreseen the future of the production quantity and for inventory management in order to balance the conflict of not wanting to hold too much stock thereby tie up capital and the desire to make items or goods available when and where required so as to avert the cost of not meeting such requirement [2]. Forecasting ensures that the problems of over production or under production of quantity of goods in an industry at the right time will be handled and elimination of forecasting can cause business failures. If a product is not available when the customer thinks it should be, the retailer and the company will lose a customer not only on that product but also likely to continue loosing more customers on the future production. Furthermore, the application of forecasting techniques is very essential for an effective management and can make a significant contribution to a business profit as well as increase its return on total assets. It is thus the management of the future production at the right time and the right proportion. The reason for greater attention to forecasting is that it helps the industry to understand whether the future is profitable or not, and also

the appropriate quantity of goods necessary to produce or stock over future time. Essentially, it coordinates the activities of the production planning and control in a manufacturing industry.

The **objective** of the study is to apply some existing forecasting methods in order to show the true quantity of the products in the right proportion and at the right time in Louis Carter plastic manufacturing industry.

II. Review of Literature

2.1. Categories of Forecasting Methods: Qualitative forecasting techniques are subjective, based on the opinion and judgment of consumers, experts; they are appropriate when past data are not available. They are usually applied to intermediate- or long-range decisions. Examples of qualitative forecasting methods are informed opinion and judgment, the Delphi method, market research, and historical life-cycle analogy.

2.2. Quantitative forecasting models are used to forecast future data as a function of past data; they are appropriate when past data are available. These methods are usually applied to short- or intermediate-range decisions. Examples of quantitative forecasting methods are last period demand, simple and weighted N-Period moving averages, simple exponential smoothing, and multiplicative seasonal indexes.

2.3. Naïve approach: Naïve forecasts are the most cost-effective objective forecasting model, and provide a benchmark against which more sophisticated models can be compared. For stationary time series data, this approach says that the forecast for any period equals the historical average. For time series data that are stationary in terms of first differences, the naïve forecast equals the previous period's actual value.

2.4. Time series methods: Time series methods use historical data as the basis of estimating future outcomes.
2.4. Causal / Econometric Forecasting Methods: Some forecasting methods use the assumption that it is possible to identify the underlying factors that might influence the variable that is being forecast. For example, including information about climate patterns might improve the ability of a model to predict umbrella sales. This is a model of seasonality which shows a regular pattern of up and down fluctuations. In addition to climate, seasonality can also be due to holidays and customs; for example, one might predict that sales of college football apparel will be higher during the football season than during the off season [3].

2.5. Causal forecasting methods: These methods are also subject to the discretion of the forecaster. There are several informal methods which do not have strict algorithms, but rather modest and unstructured guidance. Alternatively, one can forecast based on, for example, linear relationships. If one variable is linearly related to the other for a long enough period of time, it may be beneficial to extrapolate such a relationship into the future.
Causal methods include:

- Regression analysis includes a large group of methods that can be used to predict future values of variable using information about other variables. These methods include both parametric (linear or non-linear) and non-parametric techniques.
- Autoregressive moving average with exogenous inputs (ARMAX) [4].

Quantitative forecasting models are often judged against each other by comparison of their in-sample or out-of-sample mean square error, although some researchers have advised against its use [5].

2.6. Importance of Forecasting in an Organization: Vadasz [6] reviewed that forecasting is important for several reasons. First, it enables management to change operations at the right time in order to reap the greatest benefit. It also helps the company prevent losses by making the proper decisions based on relevant information. Organizations that can create high quality and accurate forecasts are able to "see what interventions are required to meet their business performance targets".
Forecasting is also important when it comes to developing new products or new product lines. It helps management decide whether the product or product line will be successful. Forecasting prevents the company from spending time and money developing, manufacturing, and marketing a product that will fail.
Stockholder expectations highlight another reason behind the importance of forecasting. Public companies experience scrutiny and pressure for short-term performance from investors. Operational results will be examined by investors and investment analysts, and actual results that differ from forecasts will be bad for the company and its stock price. This is because both meeting predictions and exceeding predictions will reduce investor confidence. This will cause investors to believe that the company does not understand its own business model.

2.7. Time Series: a time series is a sequence of data points, measured typically at successive points in time spaced at uniform time intervals. Examples of time series are the daily closing value of the dow jones industrial

average and the annual flow volume of the nile river at aswan. time series are very frequently plotted via line charts. time series are used in statistics, signal processing, pattern recognition, econometrics, mathematical finance, weather forecasting, earthquake prediction, electroencephalography, control engineering, astronomy, and communications engineering.

Time series analysis comprises methods for analyzing time series data in order to extract meaningful statistics and other characteristics of the data. Time series forecasting is the use of a model to predict future values based on previously observed values. While regression analysis is often employed in such a way as to test theories that the current values of one or more independent time series affect the current value of another time series, this type of analysis of time series is not called "time series analysis", which focuses on comparing values of time series at different points in time.

Time series data have a natural temporal ordering. This makes time series analysis distinct from other common data analysis problems, in which there is no natural ordering of the observations (e.g. explaining people's wages by reference to their respective education levels, where the individuals' data could be entered in any order). Time series analysis is also distinct from spatial data analysis where the observations typically relate to geographical locations (e.g. accounting for house prices by the location as well as the intrinsic characteristics of the houses). A stochastic model for a time series will generally reflect the fact that observations close together in time will be more closely related than observations further apart. In addition, time series models will often make use of the natural one-way ordering of time so that values for a given period will be expressed as deriving in some way from past values, rather than from future values (see time reversibility.)

Time series analysis can be applied to real-valued, continuous data, discrete numeric data, or discrete symbolic data [7].

2.7.1. Methods for time series analyses: Methods for time series analyses may be divided into two classes: frequency-domain methods and time-domain methods. The former include spectral analysis and recently wavelet analysis; the latter include auto-correlation and cross-correlation analysis. In time domain correlation analyses can be made in a filter-like manner using scaled correlation, thereby mitigating the need to operate in frequency domain.

Additionally, time series analysis techniques may be divided into parametric and non-parametric methods. The parametric approaches assume that the underlying stationary stochastic process has a certain structure which can be described using a small number of parameters. In these approaches, the task is to estimate the parameters of the model that describes the stochastic process. By contrast, non-parametric approaches explicitly estimate the covariance or the spectrum of the process without assuming that the process has any particular structure.

Methods of time series analysis may also be divided into linear and non-linear, and univariate and multivariate.

III. Research Method

The research method used in this work is a quantitative research approach.

3.1. **Data Collection and Analysis:** The data gathered were the daily record of plastic pipes production over the month for three years. The method used was time series technique to model for the quantity of pipes (sizes and shapes) to be produced in the industry using predictive tools namely: Excel and Minitab tools for the development of the model and the forecasting of the results.

Table 1: Presentation of 2011-2013 Monthly Data on Quantity of finished products in the Industry

Year	*Month*	Y1
2011	Jan	16509
	Feb	29233
	Mar	26649
	April	52012
	May	14143
	June	23070
	July	29873
	Aug	17964
	Sept	3231
	Oct	7028
	Nov	15997
	Dec	3154
2012	Jan	7096
	Feb	7267
	Mar	22102
	April	21117
	May	18831
	June	22155
	July	8750
	Aug	14773
	Sept	11958
	Oct	5501
	Nov	17515
	Dec	18435
2013	Jan	22208
	Feb	14106
	Mar	14485
	April	15997
	May	24117
	June	29080
	July	16964
	Aug	17281
	Sept	5600
	Oct	20614
	Nov	4374
	Dec	11892

Source: Louis Carter grouped data
Y1= 10litres bucket,