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Business Intelligent Smart Sales Prediction Analysis for Pharmaceutical Distribution and Proposed Generic Model

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Abstract : The role of SALES FORECASTING in Pharmaceutical distribution companies (PDCs) cannot be belittled by enterprises, as the process of outlining business plans that are accurate and ensure complete advantage, have a forceful impact on the robust sales for the enterprise. This study therefore aims to develop a generic model “Business Intelligent Smart Sales Prediction Analysis”, to predict sales for PDC. The presented method is a combination of Real Time application (RTA) tools and Time Series Forecasting (TSF) methods. In Pharmaceutical distribution companies, Inventory Management is the greatest challenge since companies are in a continuous effort to increase their profits and reduce their costs. The Time Series Prediction sales models were built with different approaches including ARIMA methodology, Neural network, Advance neural network, Fuzzy neural network and more . The offered Hybrid method is a real time data mining approach with a combination of an earlier defined factor and new factor. The result indicates that the proposed method is able to approximate prediction on a real time basis.

Keywords: PDC’s, RTA, TSF

1.INTRODUCTION

Enhancing sales and operations planning through forecasting analysis and business intelligence is demanded in any industry and business. Thus in Pharmaceutical distribution companies, sales forecasting plays a major role for enterprises in making business plans more accurate and gaining competitive advantage. For Pharmaceutical Distribution Company, Inventory Management is the biggest challenge because companies are in a continuous effort to increase their profits and reduce their costs. Forecast will be used as a way to prevent costs of excessive inventory and to prevent losing their customers owing to the shortage of drug. Thus, it impacts the growth and profit to the business. In pharmaceutical industry, successful sales forecasting systems can be beneficial, due to the short shelf-life of many pharmaceutical products and the importance of the product quality which is closely related to the human health.

Currently PDCs face several challenges, including huge inventory cost, tough competition and stringent ministry rules.

Considering the situation PDCs are compelled to meet their customer needs by delivering right amount of medicines at the right time. Shortage and surplus of goods can lead to loss of income for PDCs.

Distribution of pharmaceutical products in Oman is mainly by Supplier or Wholesalers, who buy stock from manufacturers or sub-agents and sell the same to their customers (Hospital, Pharmacies, Malls, Institutions or Clinics).

Figure 1: The Graphical organizers depict the flow of Pharmaceutical distribution channel in Oman.

1. Institution:

(Ministry of Health, Ministry of Defence, Director General of Civil Aviation, Royal Hospital) Pharmaceutical distribution companies supply pharma products in two segments. Ist: Institution Supply 2nd: Private Market

Institution: Institutions like the Ministry of Health, the Ministry of Defence; Directorate General of Civil Aviation & Meteorology (DGCAM), Sultan Qaboos University and Hospitals etc raise tender enquires and float the same to all PDC in Oman. PDC Float enquiry to various manufacturers and invite quotations based on the relevance of quotations, PDC submit their tenders. Tender is awarded by the institution and given to PDC for product supply on a bulk, lot wise or schedule wise. As product requirement is received from the supplier, the products are supplied to various institutes as per LPO (Local purchase order).

Private Market: Salesmen gather requirement details from various customers via clinics, hospitals, malls or pharmacy outlets and raise requisition. On the basis of this requisition, PDC supplies products to customers from available stock or raise Purchase Order to manufacturers as per demand and supply to customers.

Note: PDC maintain their stock on the basis of historic data and market trends. PDC in Oman are generally believers of traditional statistical techniques (Historic data calculation) to make sales predictions for the products. Since sales prediction must be performed with high accuracy within limited period of time, it is impossible to do it with manual or traditional methods. Thus it is advisable to apply one of the data mining techniques to enhance the accuracy of sales prediction on the shortest period of time.

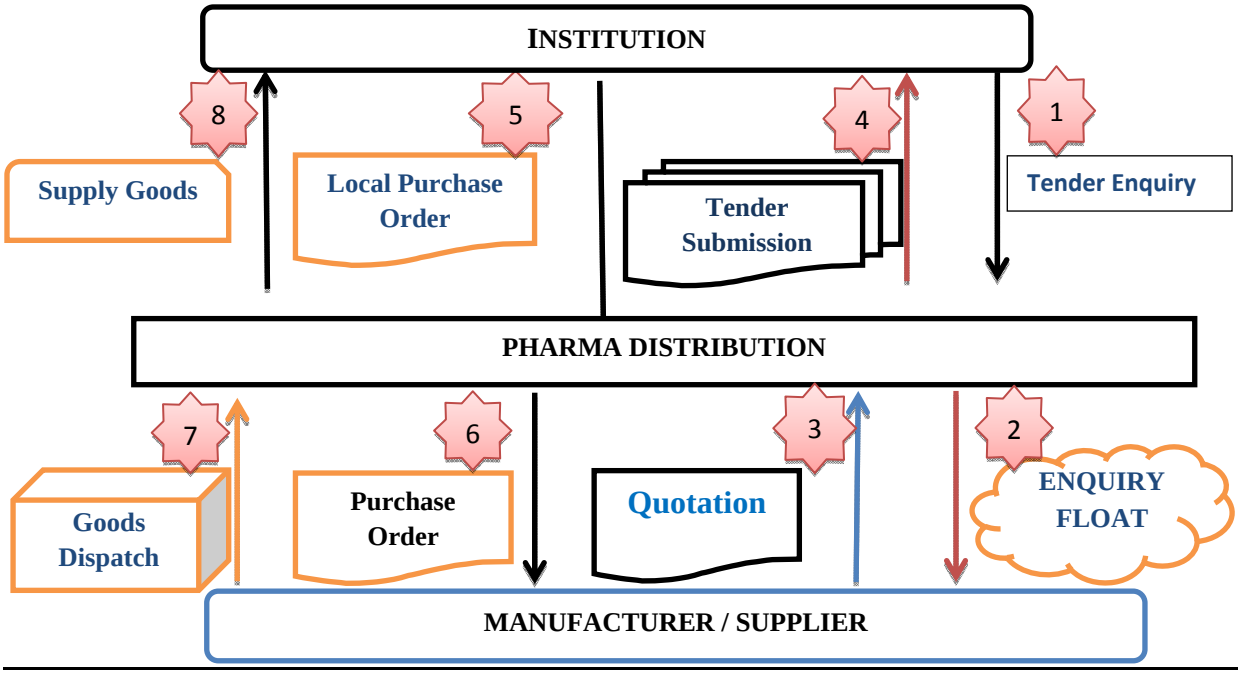

Figure 1: Pharmaceutical Distribution Channel

Private Market

(Hospital/ Clinic, Pharmacy and Malls**)**

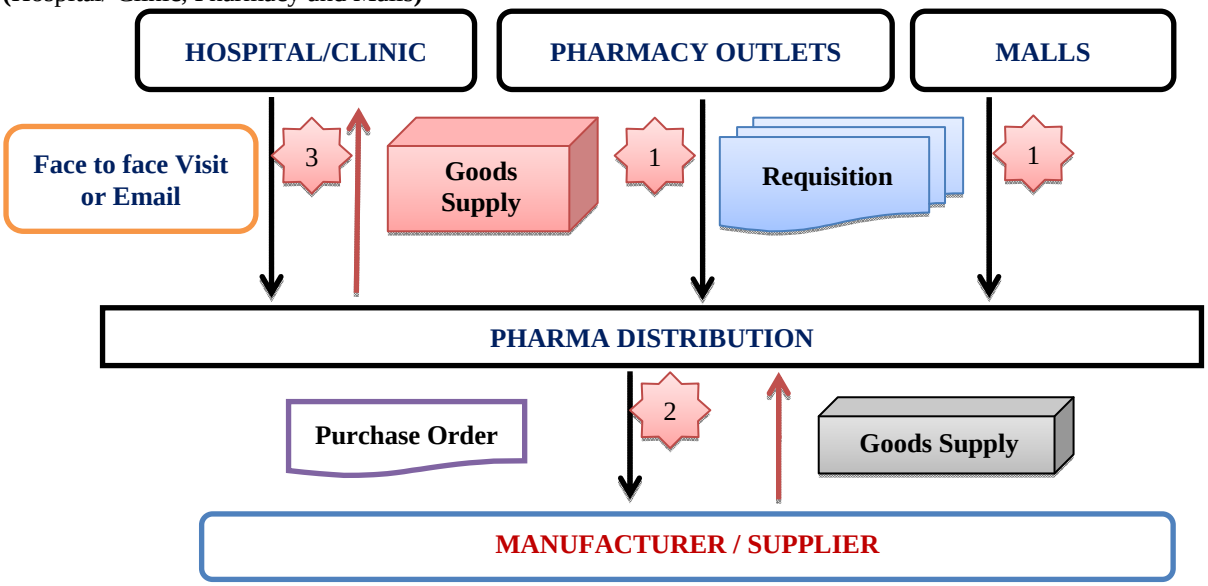

Figure 2: Pharmaceutical Distribution Channel (Private Market)

My research will encompass the required data from a leading Pharmaceutical distribution company in Oman, which has diversified from its core areas of Pharmaceuticals, hospitals, laboratory instruments and equipment and surgical products to a wider range of internationally known Perfumes and cosmetics, Baby care, Health foods, Veterinary, Agricultural and Fertilizer products. It also has an array of 1200+ the choicest Consumer products that are retailed and wholesaled across the country. As the company has a leading position in the market the company needs to have large product inventories in order to meet customer's demand, as shortage of drugs is not acceptable in this industry. The company makes all attempt to update inventories for the needs of the next three months stock or up to minimum stock level in advance. This is how excessive cost and investments leads to PDC. Inventory control, transportation and financial costs contain a high percentage of total expenses in PDC. Thus intelligence sales prediction analysis will help for future sales in order to reduce undesired inventory costs and increase profits while keeping the customer satisfied.

2. LITERATURE REVIEW

2.1. Rationale and significance of study

"Prediction is very difficult, especially if it's about the future "- Nils Bohr. When it comes to forecasting sales in a Pharmaceutical business it is a complex task. The issues related to companies vary from company to company that has been highlighted here with the help of the literature review:

1. Large number of SKUs (Stock Keeping Units): It is imperative that PDCs maintain a large number of SKUs because of the unique characteristics of pharma products, maintaining focus on the sales behavior of each SKU, thus, becomes complicated and therefore a set of general rules needs to be defined for forecasting.
2. Geographic Diversity: Geographically diversity is an important factor for PDC's to catering the needs of spread customers. Thus the demands of different products are as per regional/ location demands.
3. Diverse therapeutic segments: The major effort of the sales is to organize sales around therapeutic segments. Every brand is sold depending upon the size of the therapeutic segment and the competition within the therapeutic group.
4. Campaign Period: Campaigning is an integral part of the sales activity. This includes briefing doctors, doctors' conference, and distribution of samples and other marketing activities during the campaign period. These help in stimulating the demand pattern.
5. Differential Brand promotion: Different schemes are launched time to time and gifts too are offered by pharmaceutical companies to promote the brands. This happens generally before and after a much lower sale due to drying up and over filling of the stock pipeline.
6 New Products: Sales of new products have unpredictable pattern. Factors like availability, right- communication; medical rep's training go a long way to promote a brand.
7. Re-launched products: Repositioning a brand in the market may sometimes have change in sales. At times effective communication and other initiatives taken may lead to a significant growth in sales.
8. Seasonal products: Seasonality product may boost the requirement of certain drugs and this shows a seasonal variation in sales. The effect of this variation is high on certain pharma products and low on certain other products.
9. New Stockiest or Credit Limit: New opening of stockiest or when the credit limit is enhanced those results in an artificial flip in primary sales. Such instances need to be taken care while forecasting.
10. Larger Batch Size: On some products a large inventory needs to be maintained due to large batch size for sales of the product. Thus larger batch size will take care of large sales fluctuation without disturbing the supply of the product. In such cases even higher sales forecast accuracy does not yield real value to the organization.
11. Manufacturing arrangement: Corrected sales forecast figure helps to reduce the overall cost of making the product available in time at the right place with lower inventories. Manufacturing arrangement (Loan License, third party, Own) plays a major role in determining sales forecast horizon on the supply side.
12. Formulation type: Certain products or formulation types like cream, gel or ointments etc. depends upon utilization. If utilization is less, then sales forecast goes inaccuracy which can be handled though at a cost. Thus, the common facilities make the challenge of having a more accurate forecast gains more significant.

2.2 Sales prediction methodology

Researchers have extensively worked and examined alternative methods to find out the most efficient sales prediction methodology. They have identified important aspects of time series data to enable sales forecasting. This has predominantly been done by using statistical based methods like Linear Autoregressive models (AR) which is flexible to model many stationary processes. The ARMA (Autoregressive Moving Average) model given by (Fan and Yao, 2003) which was further extended by (Weron and Misiorek, 2008) is used for short term time series forecasting. The ARMA model failed because it could not accurately predict the evolution of non-linear and non-stationary process but only gave a linear relationship between variables. Whenever there is a highly fluctuating time series data due to seasonal factors or time trends it shows a degraded performance. Therefore to remove or reduce first order non stationary variables the ARIMA (Auto Regressive Integrated Moving Average, Model) is given by (Fan and Yao, 2003). Since the ARIMA model is limited to first order non stationary variable data, the ARCH (Autoregressive Conditional Heteroskedascity) model given by (Engle, 1982) helps to capture the second order non-stationary variables. The GARCH (Generalized Autoregressive Conditional Heteroskedascity) model given by (Bollersley, 1986) shows a different function of its Autoregressive terms and allows a restrained representation of the time series. (Tong, 1990) applied a time series model for forecasting in Economics and Neuroscience (Yadav, 1994) which was called the ARMA model (TAR) (Tong, 1990). (Lineesh and John, 2010) decomposed time series data and then used ARMA and TAR models to forecast each decomposed data. (Krishnamurthy and Yin, 2002) combined Markov and AR models under a Markov pattern where the AR parameters changed according to the realization of a finite Markov chain for non-linear time series forecasting. Therefore, most of these methods are limited to non-linear and stationary time series forecasting assuming an AR type structure.

The last few decades have seen the superior performance of Artificial Neural Networks (ANN) in classification and regression problems and have received focused of attention in the time series forecasting methods. When we compare ANN with the previous statistical techniques we find that ANN has many unique features such as

- Both non- linear and data driven
- Not having requirement for an explicit underlying model
- Since it is more flexible and universal, it is applicable to complicated models

Neural Network is widely used in a range of applications in time series forecasting varying from financial, economic, weather changes, earthquakes etc. These models have

approximate continuous function and do not need to be assumed on the form of non-linearity (Park and Sandberg, 1991). (Zang, 2012) reviewed the NN model for time series forecasting.

(Lapedes and Farber, 1987; French, 1992) gave a back propagation algorithm for non-linear time series forecasting through Feed forward Neural Network (FNN) model. The performance of this model is found to be better than the traditional statistical methods such as regression and the approach of (**Box Jenkins**) in the functional approximations, but they are time invariant and assume the dynamics, based in the time series data. FNNs with intermittent feedback have been used for time series forecasting. (Grudnitski and Osburn, 1993; Kuan and Liu, 1995) gave the Recurrent NN (RNN) models to allow the non-linear time series forecasting. For multistep forecasting of chaotic time series (Menezes and Berreto, 2008) came up with recurrent network structures with non-linear AR models with exogenous input. To capture different trends and volatilities in time series, various types of Radial Basis Function (RBF) NN models, like employing dynamic regularization (Yee and Haykin, 1999), orthogonal least squares learning (Chen et al.,1991), and recursion (Chen et al, 1992) have been investigated. Barreto (2007) used Self Organizing Map (SOM) NN models to review time series forecasting. The forecasting accuracy of nonlinear time series can be improved by the local approximation property inherent in these models compared to global models such as FNN. They allow the network architecture to grow, based on the data by averting the need to specify the number of neurons in advance. There was also an attempt to use Ensemble (Zhang and Berardi, 2001; Lai et al, 2006) or hybrid NN models (Kodogiannis and Lolis, 2002; Zhouet al 2004), such as wavelet NN models, for nonlinear time series forecasting. SVMs that are categorized into linear, Gaussian or RBF, polynomial, and multilayer perceptron classifiers use a class of generalized regression models, such as Support Vector Regression (SVR) and Least Squares Support Vector Machines (LS-SVMs; Smola and Scholkopf,2004), that are parameterized using convex quadratic programming methods (Balabin, Lomakina, 2011). To get a better forecasting performance than conventional techniques (Cao, 2003) a linear regression is constructed by minimizing the structural risk. To overcome the regression and classification problems a new type of neural network called Extreme Learning Machine (ELM) has been introduced. To overcome the limitations of ANN like the black box techniques, over fitting and getting trapped in local minima the researches preferred hybrid techniques to develop the efficient forecasting model. To predict the financial times series data of Taiwan Stock Market, Chang Pei applied a combination of wavelet and (Takagi Sugeno Kang TSK) fuzzy rules based system. Many researches prefer this theory as it is efficient in handling uncertainties. The forecast of Taiwan Stock Exchange was made on the basis of multiple period modified equations derived from adaptive expectation model (Cheng Ching-hsue, 2007). To forecast a financial time series data in which genetic algorithm and gradient descent learning algorithm are used alternatively in a repetitive manner, then to adjust the parameters until the error is less than the required value then a Fuzzy Neural Network is used. To predict financial time series (Slim Chokri, 2006) used a hybrid Neuro fuzzy architecture based on Kalman Filter and used Mackey glass time series as experimental data.

For the prediction of Shanghai Stock Market indices (Fu-yuan Huang, 2008) adopted a combination of improved particle swarm optimization (PSO) algorithm and fuzzy neural network. He applied genetic fuzzy neural network to forecast Shenzhen stock indices.

Another well-known convenience store Franchise Company in Taiwan where weights are generated by GA used a neural fuzzy model (Kuo I-Hong et al., 2009) to forecast sales data.

Interval type-2 fuzzy neural networks have been used to forecast financial time series data. Both PSO and differential evolution (DE) algorithms are used for training the weights of the network.

Most of the models given above involve batch processing where the model is fit and updated regularly using batches of historic data. But because of its extent due to the prohibitive computational effort, memory requirements, and large data sizes hampers its applicability to many real world problems, especially for online process monitoring. To overcome this limitation a variety of sequential (also known as online or recursive) forecasting models, such as Hidden Markov Models (HMMs; Rabiner 1989), are investigated. This is a special group of mixture models, where the observed time series is treated as a function of the underlying, unobserved states vector which may be reconstructed from autoregressive terms. In general terms, state space models such as Kalman Filter (KF) and Particle Filter (PF) (Arulampalam et al . 2002) can be classified as HMMs. Extended Kalman filters (EKFs; Wang et al 2009) have been attempted for non-linear time series forecasting so that the restrictive Guassian and linearity assumptions in KF are relaxed. An EKF model still assumes a Gaussian posterior and uses a first order Taylor series expansion to approximate state dynamics. To overcome this limitation Unscented KFs (UKFs) (Wan and vander Merwe, 2000) have been introduced. Instead of local linearization and to avoid the Jacobian matrix calculation inherent in EKFs, UKFs choose a small sample of points to achieve a more accurate estimate of local dynamics, and the evolution of these sample points is propagated at each estimation step. Thus classification of non-linear, non-stationary methods are applied to time series databases, which are also an important factors for data mining.

Therefore:

2.3 Methodology studies on sales forecasting by using a time series method

1. Auto Regression (AR),
2. Moving Average (MA),
3. Autoregressive Moving Average (ARMA)
4. Traditional time series methods
5. Fuzzy logic
6. Neural Networks
7. Fuzzy neural networks
8. Artificial neural networks (ANNs)

9. Back propagation Neural Network (BPNN)

2.4 Factors Already Studied

1. Historic Data
   a. Quarterly Analysis
   b. Half-yearly Analysis
   c. Yearly Analysis
2. Seasonal Sales (Seasonality)
3. Marketing Activity
   a. Brand activity promotion
   b. Product Display
   c. New launch
   d. Media Campaign
   e. Distribution Drive
4. Future price or price factor of the product
5. Lead time for supply
6. Min stock level maintenance.
7. Company interest / Investment (Man power) towards product

3. RESEARCH METHODOLOGY AND THE PROPOSED PLAN OF ACTION

The overall procedure of this research consists of:

1. Data collection and preparation:

Secondary data collection will be collected from Muscat Pharmacy LLC. Company will provide historical data of nearly 3000 kinds of medicines (Pharmaceutical, Surgical, Commercial, Engineering, Lab, Veterinary and Chemical) which were sold during Six - Seven years.

2. Exploratory Analysis: Exploratory analysis it to concluded because

(1) Medicines are different in characteristics and sales behavior,

(2) It's not possible to make a single prediction model for all medicines

(3) Both linear and nonlinear relationships among sales records, but there were mostly nonlinear. Thus, it is logical to mainly apply nonlinear or even hybrid models in this research and consider linear models as the second priority.

3. Graph based analysis

Graph bases analysis will be performed to find the sales behavior of medicine using pass sales record.

4. Generic model application on sales prediction A **generic model** "Business Intelligent Smart Sales Prediction Analysis." Will be developed which a combination is of: Real time application data using recently studied methodology - Data mining techniques with a combination of New proposed factors (With the help of gap finding) and already studied factors.

Factors which are already studied

1. Historic Data
   a. Quarterly Analysis
   b. Half-yearly Analysis
   c. Yearly Analysis
2. Seasonal Sales (Seasonality)
3. Marketing Activity
   a. Brand activity promotion
   b. Product Display
   c. New launch
   d. Media Campaign
   e. Distribution Drive
4. Future price or price factor of the product .
5. Lead time for supply
6. Min stock level maintenance.
7. Company interest / Investment (Man power) towards product factors, which defined from gap finding

1. Marketing Dynamic
   a. Doctor Interest
   b. Representative Interest
   c. Sales Channel / Tender / Contract / Floating Customer
2. Contingency Plan
3. Min Order quantity or Min Order Value
4. Non availability of competitive product
5. Perfect order delivery Status and Real time nformation exchange between customers and PDC
6. Data sampling for model fitting and testing Secondary data collection will be collected from Muscat Pharmacy LLC. for model testing and find the prediction result considering various factors .
7. Model evaluation
   1. Model evaluation testing will be done based on previous prediction result and the result predicted from generic model
   2. Result outcome considering various factor (Old + New)
   3. Prediction result calculation in terms of speed and accuracy.
8. Finally conclusion:

Study Implications

Theoretical Implication

1. New Factor help for accurate prediction.
2. Maximum factor is to be considered before product prediction.

Practical Implication

1. Sales Analysis of Pharma Distribution Company.
2. Resolve Problem of Pharma Distribution Company to Prevent Losing Customers due to Drug Shortage.
3. Settle problem of Pharma Distribution Company, how to Control Inventory Level in Order to Prevent Costs of Excessive Inventory.
4. To Establish Sales Prediction by Considering Market Competition and Tough Ministry Rules.

4. CONCLUSION AND FUTURE RESEARCH DIRECTION

This paper herein, consist of a comprehensive review of the literature on Sales forecasting on pharmaceutical distribution company has been conducted. I intend try to explore the advantages and the drawbacks of different kinds of analytical methods of sales forecast on pharma distribution. It will also be my endeavor to find the defined

factors of the real world application of pharma sales forecasting after extensive literature review and gap analysis. Thus, the basic objective of this research was to create a generic model (software application), namely "Business Intelligent Smart Sales Prediction Analysis." Which will cover both already-studied factors and new factors, and offer a novel and precise sales prediction method to help companies, especially PDC, to forecast product sale and tuning inventory management policies in order to prevent costs of excessive inventory and prevent the loss of customers due to drug shortage. To validate the proposed method, three to five year monthly sales data will be gathered from Muscat Pharmacy LLC. In data preprocessing phase, raw data will be prepared including maximum factors to suit the research objectives. Then exploratory analysis will be conducted to better specify the nature of data. Finally, a comprehensive graph based analysis will be performed to find item grouping and visualize the network of drugs.

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