

Challenges and Strategies for Sales Prediction in Apparel Industry

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Abstract — The apparel industry facing many challenges while predicting future sales of clothing items. This paper conducts a comprehensive review of all challenges and problems faces by textile industry. Some least considered factors in literature mentioned thoroughly to get intention of researchers toward them. Then discuss some proposed algorithms to face these challenges of sales prediction in apparel industry. Some future requirements and area of demanding researches also describe by concluding literature review.

Keywords — Textile Industry, Artificial Intelligence, Sales Forecasting, Literature Review.

I. INTRODUCTION

Sales forecasting is one of the main parts of manufacturing organizations. Errors in forecasting results leads to many problems such as stock-out or excessive stock etc which increase the cost and decreases the revenue. In textile filed there are a lot of factors, needed to deal while this process. Textile items sales forecasting depends on user choices and customer is always un-predictable. These items having short life cycles and long manufacturing and shipping time required. Therefore, long term forecasting is also needed which can be affected by bullwhip phenomenon.

Now a days, the fast change in fashion trends and variability of fashion goods also increase the complexities of clothing sales forecasting. The large number of stocks keeping unit SKUs have to manage simultaneously [1]. There is also a factor is “new product” sales forecasting. Previous sales record can largely assist while doing future sales forecasting of an item. But it’s become a more challenging task to predicts demand value of a new product.

There are a number of different challenges [2] faced by textile organizations while sales forecasting such as seasonality of products, choose proper horizon of data to forecast properly, long time for shipping purpose because mostly manufacturing units established at low labour cost countries [3], fiancé early on the basis of prediction, select proper marketing strategies to overcome the competitors in the market and many more. The first section of this paper mentioned some important and least considered points those effect on sales forecasting. Without considering these factors its nor possible to get

demanding accurate results. There is a need to get intentions of research towards these prompting factors while designing sales forecasting systems.

On the other hand, some models designed by researchers interested in this field in the literature. For prediction purposes, times series algorithms having much importance while doing simple statistical and previous-data based sales prediction. To overcome all the challenges faced by textile industries some soft computing or artificial intelligence (AI) based models also designed [4]. These algorithms work very fast and efficiently in this field.

In second part of this paper some simple, AI based and hybrid models reviewed specifying the problems which are controlled by using these systems. This study can provide the proper image of textile challenges and their expected solutions already available and utilizes as well as future demand to get more accurate results of sale prediction for apparel goods.

II. CHALLENGES OF TEXTILE INDUSTRY SALES FORECASTING

There are numerous factors effect on sales of textile items such as customer behaviour, customer choice, fashion trends, country economic conditions globalize market using IT, large competition, seasonality in products and much more. These attributes directly effect on sales and in directly on sales forecasting. Due to these factors a single forecasting model cannot be dealt with all types of problems or challenges. A number of sales forecasting models proposed in literature according to accommodate different problems discussed in (section III). Some least considered challenged towards textile business are discussed below which are necessary to configure for accurate sales forecasting of apparel goods.

A. New Fashion Arrival

One of the main reasons to create complications in forecasting products related to textile industry is the large number of products have to deal simultaneously. Some of these apparel goods are also in the reciprocal of one an-other. Therefore, it depends on customer that what style of product they like and give preference to which style and colour etc. This problem mostly relates to new arrivals of fashion

products. These new-fashioned products also can be affected on the old ones selling averages. Customers are always unpredictable so different strategies have to be used for forecasting of new-fashioned products. By manufacturing small stock for fresh arrival products, managers analyse their sales of few weeks and then forecast about their future demand by customer [5]. This “pre-sales” technique is often used for predicting sales of new items because they have no historical data.

In [6], an efficient system is proposed to deal with the new item sales forecasting. This model is based on classical and heuristic methods of forecasting. It automatically selects the best forecasting model according to the type of item and data regarding that item.

While designing and manufacturing process of a new or latest design product, a lot of money is expended but all these are in the state of uncertainty. Therefore, it is mandatory at the point of business, to forecast these items sales in the future which directly can empower or destruct company's business. To deal with these uncertainties, many strategies are used in literature using fuzzy logics and neural networks [7] but there is still a need to build better models to deal with new clothing products.

B. Short Life Cycle

It is a typical problem faced with many of the manufacturing businesses. By comparing the others textile and apparel supply chain, they have very short product cycles for fashion articles. Some products are sold throughout the year like white t-shirts or black trousers etc. But some items are demanding for very short spans of time like Christmas dresses or Halloween party wears etc.

Some garments products have their own seasonal life cycle such as winter collections or summer arrivals. These types of products are sold each year but with little modifications according to new fashion trends. These fashion trends are also characterized by short life cycles of product and highly volatile demand [8].

Because of this nature of textile goods, it is more complex to predict their sales. They have short life cycles and the duration of these life cycles also largely depends on different other characteristics such as customer choice and current fashion. Some models are presented in the literature [9][10][11] to deal with items having smaller life cycles.

C. Long Production Time

Textile business consists of many of the departments working to make a final product from raw yarn and cotton materials [12]. This whole process is very lengthy and time-consuming. Due to this fact of this industry, sales forecasting of apparel goods becomes more complex and uncertain. Retailers have to do forecast long time ago for the final

product sales time. But at the actual selling time, the situation may differ from the forecasting time.

Many decisions like raw material orders, establishing units, inventory management and replenishments etc. have to be taken on just the basis of sales forecasting of items. There is a long time between these forecasting and product placement in the stores or in the hands of the customer. Therefore, long production time factor increases the uncertainty and complexity of the prediction process [13]. Number of systems based on fuzzy logics [14][15][16] are proposed in the literature to deal with the short term and medium term forecasting of apparel goods but there is a need for models that can also deal with long term forecasting in this field.

D. Weather Conditions

Weather conditions cannot be predicted for a long-time period but retailers of the textile market have to forecast their apparel goods sales on long-term horizons. To choose a long-term horizon means better estimation but with a higher rate of errors in these forecasting results also [17].

However, weather conditions do not impact on non-seasonal products such as undergarments and party wear fabrics etc. But some seasonal products have a great selling impact on weather. To forecast about seasonal products is a complicated task because weather conditions for some specific months of selling are unpredictable for years ago. Some potential choices are proposed in [18] based on seasonal components, whether in product or not.

E. Large number of Products

In the textile industry, one of the main constraints towards accurate sales forecasting is the large number of SKU (Stock Keeping Unit) [3]. Because customers always demand for a vast variety of apparel products based on fashion trends, seasonal wears, styles, sizes and colours etc. These large number of products also implement their effect to each other as customer choices at selling time.

Apparel companies require high precision values for inventories. Small number of variations in colours, sizes and little modifications in styles of final product produce a large number of patterns, changes on sales graphs. These are the reasons that make inventory management of textile goods difficult.

In [19], an efficient inventory management model is proposed to deal with these types of companies because traditional techniques of sales forecasting cannot work properly with large number of variations in products. In past years many different models have been established in this regard but each model has some limitations and is inappropriate to overcome this problem.

F. Market Competitors

This fact cannot be ignored while making sales forecast because it directly and indirectly impacts on

manufacturing businesses such as textile [20]. Actually, what competitors do can be impacted on someone's business [21]. If one company surprisingly offer products on very low rates so other competitors also have to offer discounted prices to avoid excessive inventory problems and lose market shares. Therefore, managers or retailers have to analyse about their company's selling shares in respective market. It can assist a lot while making forecasts about apparel products sale. If this parameter includes in sales forecasting products then it can be positively increased the efficiency and performance of forecasting systems. This hypothesis could be the part of study as well in future.

Some naive based and linear models produce better results while examining competitor's data to predict own market shares than other econometric models [22]. By reviewing literature an assessment is get that there is much need to establish market share prediction models. Some models are noted in [23] but it is a most demanding topic for future research at this point for textile and other manufacturing businesses.

III. STRATEGIES USED FOR SALES FORECASTING IN TEXTILE FIELD

Sales forecasting is a fundamental and essential step for many manufacturing industries. Their planning and different supply chain and marketing strategies very much depending on sales forecasting. According to sales forecasting managers or retailers decide that how much raw material have to order, how much manufacturing units needed and how-to maximizing revenue and minimizing cost of manufacturing by avoid extra raw materials. By using sales forecasting results managers plan strategies to avoid stock-out and excessive stock problems.

In textile field many factors impact on sales of textile goods therefore, its much important to choose best forecasting model according to a specific type of item or items family. There are numerous models proposed in literature [24][25] depending on different factors those can affect sales of apparel goods. The large number of different items in textile filed make sales forecasting more complex task. Some items have historical data as seasonal products, undergarments or casual wearing cloths. This historical data can utilize to get maximum information about these items future demand. Some traditional models based on statistical or regression operations, can be used in this scenario. But some new or fresh arrivals introduced in market have no historical data like new fashioned cloths. To deal these types of items some artificial intelligence models impose in forecasting systems. Except these to increase the efficiency or speed of historical items sales forecasting hybrid systems are also developed in past years

A. Statistics based Systems

Forecasting systems based on just statistical methods are old fashioned and not very efficient. Time series algorithms are one of the most popular and high superiority algorithms. But in apparel industry their use is limited. Its cause is that too many factors, some mentioned in (Section II) effects on textile items sale. Therefore in [26], a hierarchical forecasting algorithm proposed to manage this influence of other factors on future sales of apparel goods. Another approach proposed in [27] to hierarchical forecasting for both top-down or bottom-up approaches of all series of sales data depending on regression.

Bayesian methods also can used for forecasting methods. The proposed Bayesian forecasting model [28] based on a general formulation of the items life cycle in application of fashion items. Its objective was to present the statistical representation of sales demand series. A classification based IDAIC (Items forecasting model by Distribution of Aggregated forecast and Items Classification) model is used for mean-term forecasting [29].

To overcome the problems of seasonality and limited data a seasonal discrete grey forecasting model (SDGM) is proposed which based on knowledge-based systems and shows fine results than ANN and AR models [30]. There are also many other old methods as ARIMA [31], Holt winters [32], or regression methods [33] used in past but all these are not very efficient for apparel sales forecasting.

B. Artificial Intelligence based Systems

It is the fact that only using mathematical or statistical tools are not enough to get accurate results of sales forecasting. The most important and mostly used technique of artificial intelligence in this regard is Neural Network (NN) [34] and fuzzy logics. Literature proved that NN based models outperforms the traditional forecasting method made by specialists that can analyse the curves of past years sales and predict future sales. In [35], researchers conclude that evolutionary neural network (ENN) systems can provide more accurate results than specialist forecasting group. Other versions as Multi-Layer Perceptron (MLP) and Elman Recurrent Neural Networks (ERNN) models can also be used [36].

AHFCCX (Automatic Hybrid Forecasting model with Corrective Coefficient of explanatory variable influences) [37] models collaboratively used to get short and mean term forecasting. Then compared with other FPS and dynamic regression model (DRX) and results shows better remarks for these AI based systems [38]. Textile items having multiple characteristics those can impact on items sales. To manipulate all these factors a multivariate fuzzy model proposed [33]. This model can work on multi

variables of items as colour, time and size and these variables could be extended to more other variables.

Decision trees can also be used to make prediction in fast and easy way. Although their limitations are sometimes criticized in [39]. C4.5 algorithm [40] is mostly used because of its predictive accuracy

C. Hybrid Systems

To enhance the accuracy, efficiency and performance of sales forecasting models, researchers merged statistical and artificial intelligence models or different advance models based on AI techniques [25]. All these models introduced as different hybrid models. This approach not only combine the working techniques but also combines the characteristics and benefits of both statistical and machine learning algorithms.

ARIMA and ANN models have a positive response to get successes in their own linear or nonlinear domains but both cannot be use in all circumstances. The combination of both these models show better forecasting results and minimized the error rate [41]. To tackle the problem of medium-term sales forecasting a hybrid intelligent model proposed which outperforms than traditional ARIMA and ANN models [42].

A mean-term forecasting model which is composed of fuzzy inference and classification techniques for textile industry was proposed [43]. This system overcome the seasonality, reduced historical data and other exogenous factors those affected on textile items sales. To overcome the uncertainty of data in apparel goods a global forecasting support system developed.

This system is based on soft computing techniques such as fuzzy logic, neural

networks and evolutionary procedures, permitting the processing of uncertain data [44].

For a new product, the classification problem occurs to find out the class or family of new product.

To find out the class or family of new product and associate its future sales, classification problem may occur. In this regard, the combination of kernel based regression and ordinal logistic regression use in combination [45].

IV. CONCLUSIONS

In this study, we reviewed and examined the literature relating to sales forecasting challenges to textile industry, their problems and then solutions to those problem. To solve the challenging tasks of sales prediction times series statistical based, AI algorithms based and hybrid models proposed in the literature. We concluded that simple statistical methods are not suitable to tackle all the challenges simultaneously. Some AI algorithms outperforms old and simple mathematical models proposed and tested in literature. Many of the researchers showed their interest in developing and using hybrid

approach to combine statistical and advanced models to get benefits of both techniques.

Instead of improved working in this era, there is also a necessity of developing more enhanced and accurate models those can minimize bullwhip effects. To predict and overcome market competitors influence on sales. Manage more variables such as best color and fashion prediction while making forecasting for future sales. Enhance speed and robustness of models whose can work for both seasonal and non-seasonal products simultaneously.

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