Issues on Sales Forecasting for Apparel Industry

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Abstract*:* Sales forecasting has now become backbone of business industry due to change in the nature of business operations (Free on Board to Demand change Management). DCM business model requires that sales should be predicted first before actual order received. Prediction is always a challenging task. Moreover the sale forecast has become more critical, as the demand is uncertain. In this thesis, complete systemized forecasting method is proposed to fulfill the needs of supplier in apparel or fashion industry. Proposed method uses historical sales data to evaluate the sales forecast. This proposed method has been applied on apparel industry and has achieved effective result that has been compared with actual data. Proposed approach is flexible as it can produce pre-order at the summary level, Stock keeping unit level and color level that are useful for suppliers to manage his stock at any level. This model helps the suppliers to control the production volume of apparel products and reduces the un-wanted stock.

Keywords: DCM, FOB

1. Introduction

Inventory Planning plays very important role in any industry. But we find its great importance in Apparel and Fashion Industry. Because replenishment period is so long but selling season is small. So without proper planning supplier has to pay lot of risk .It can be excess of inventory or shortage of inventory. In case of excess of inventory supplier has to face a huge loss in the form over production and storage charges, also it may be possible goods will be out of season. In case of shortage, customer may ask supplier to ship goods through air which again face monetary loss. Because when the goods are shipped through air, then shipping charges will be very high, in this way cost may not be recovered. It may also possible that customer may impose heavily charge back against low fill rate. That is why many industry always focus and pay extra cost in inventory planning. But the main question arises that inventory planning should accurate. Poor inventory planning means no inventory planning. So when we work on fashion articles it looks very difficult task because it are all depends upon customer's taste, moreover life cycle of fashion article is very short. There are many factors that may affect it like weather, item features, political instability, weather climate, economic factor, pressure group, technological changes.

Political instability disturb the business activity on the edge of destruction. As increase in custom duty, will increase extra charges, then supplier may face losses. In this way the stock must have to sale on lower prices.

There is also possible that there will be large number of SKU (Stock keeping Unit), but limited historical sales available. In the past number of studies have been taken in this regard and different models have been proposed but every model has some drawbacks in the form of inefficiency or low speed.

In statistical method, lot of statistical methods have been deployed which include (linear regression, moving average, weighted average, and so forth). These methods have a closed form of expression for sales forecasting and it is very easy to implement and to get demanded desire. Among these benefits there are some drawbacks like selection of right statistical methods which are complicated task. Because statistical methods require expert knowledge and vast experience. On the other hand it is not guarantee that it may provide desired results. Our sales are also affected by some external factors as I have already discussed in the above paragraphs about this matter.

So due to these deficiencies many artificial methods has been deployed like fuzzy logic, artificial neural network. These model has also

some drawbacks. But these models require very large time to compete forecasting task. So in that case ELM and EELM are deployed. These are faster as compared to ANN and ENN. But they are not perfect. In particular ELM is unstable and EELM still need some amount of time to prediction. Due to these deficiencies hybrid model has been deployed. It actually combine different scheme like fuzzy logic and ANN etc.
Some industry also used supply chain Model. In supply chain model they can predict future sale based upon flow of SKU.

3. Background

Inventory planning plays a vital role in any industry. It's very essential both supplier and customer. Due to its importance many authors write on inventory control system in many industries. There are many approaches used by authors. Some authors used statistical technique, others are used artificial intelligence like Fuzzy Logic, ANN, Gray Model, hybrid technique, time series analysis, ELM, EELM and data mining techniques. Every technique has some benefits and drawbacks. Some authors convinced that gray model is best, others convinced hybrid model is best. But it all depends upon situation. Here is below review of different authors.
Na Liu, Shuyun Ren discussed in (Liu, Ren et al. 2013), different methods of forecasting including statistical and artificial intelligence (AI). He described that traditionally sales forecasting achieved by statistical method, there are many statistical techniques like moving average weighted average and time series analysis have been developed for apparel sales forecasting. But these techniques have some advantages, the main advantage of this technique is easy to implement. On the other hand it has several drawbacks like selection of method etc. Because it requires domain knowledge and some expertise. To overcome these problems (AI) methods were emerged like ANN, Fuzzy Logic, ELM, and EELM. Every method has its advantages and disadvantages. For example ANN provide better result. But it requires more time for Calculation. So ELM (Huang, Zhu et al. 2006) , (Zhu, Qin et al. 2005) has been introduced to remove this deficiency. But there are also some drawbacks of ELM, because it provides different result on every run, so EELM machine has been introduced (Yu, Choi et al. 2012) but it has also some drawbacks e.g. problem of time etc. So Hybrid model (Wu 2010),(Zhang 2003),(Sfetsos and Siriopoulos 2004),(Aburto and Weber 2007),(Pan, Zhang et al. 2009),(Lee, Shih et al. 2012) used to get the result. In this model strength of different model has been used to get the combine result. This research also opens a new way, because it proposes that sales of any product affects the calendar. For example sales on EID day in Pakistan, Black Friday in USA has been increased, so how to handle these on sales/ demand forecast in another challenge.

Yanrong Ni (Ni and Fan 2011) discussed there is number of factors that affect fashion retail forecasting. It includes season, region and fashion. It is very difficult to accurate forecast. Normally fashion products divided it many season spring, summer, autumn and winter. Traditional planning was to to get history data and get forecast of next year. With the help of that sales forecasting supplier make production planning, whole process takes 3 to 4 months. Normally production processes divide into two steps 60% and 40%. In first stage only 60% of the product has been produced, remaining 40% production depend upon market reaction. So at the end according to market requirement need extra goods. There is chances to miss the opportunity due to poor sales forecasting. There are many works has been done by author to improve two stage dynamic model of retail forecasting. ART non-leaner model has been developed to improve traditional forecasting model. Real time data has been collected from mobile and shared with production to improve the accuracy.

Ferdinando DiMartino (Di Martino, Loia et al. 2011) describes that soft computing forecasting methods are also used to define fuzziness and ambiguity in the data and the well-known Wang–Mendel method belongs to this group. It produces uncertain rules by a numerical dataset and uses a defuzzification process to get the close approximation of determination of a plotting from the input-variables space into the output-variables space. On first the data is partitioned using fuzzy training set and result data is termed as fuzzy partitions. If data set the dense enough 'according to fuzzy partitions then direct F-transformation is applied to the data set. If the data set is not dense enough then Decrement the dimension of input variable fuzzy partitions and repeat the process again. The concept of F-transform involves continuous functions but here we are interested only to the discrete case, that is to functions f assuming determined values in the points p1, ... , pm of [a, b]. After this Inverse F- transform is applied and RMSE and MAD Mean Index will be calculated. If Error index is greater than the threshold set Increment the dimension of input variable fuzzy partitions else stop the process. The author explains that our algorithm controls that the data points are sufficiently dense with respect to the set of fuzzy partitions of the input-variable domains. Moreover we can define a threshold as the starting point of a plateau zone in the plots of the RMSE and MADMEAN indexes. Beyond this value both indexes do not decrease significantly if the partition is finer, that is the number of the fuzzy sets forming the partition increases as well.

Chi-Leung Hui (Choi, Hui et al. 2014) focused to create algorithm for fast sales forecasting due to limited time and few historical availability of data. This is only due to product life cycle is very short, and many operational decisions of supply chain have been made with limited time. So an intelligent forecasting model has been made with combination of extreme learning machine and gray model. This new model has been tested with artificial data and real dataset. So he obtained an acceptable accuracy of forecasting. In fact accuracy of this algorithm (3F) is better than GM (1.1). With a tight limit time. In addition he had some managerial implications.

1) He analyses that 3F algorithm perform best on limited time and data, large variance of seasonality. So before implementation management look above these factors, if they exist than they implement this model.

2) Using this model sales forecasting has been made in timely. So in this way, they can also manage his inventory timely. Because they are managing demand and supply using this algorithm.

Author also convinced this algorithm not only meet the requirements of apparel or fashion industry but also meet the requirement of other domain like seasonal toys and electronics products. Because requirements of these domain also fast forecasting with limited time and data. Author also convinced that this algorithm used for further research such as inventory planning and simulation studies.

Yong Yu (Yu, Hui et al. 2012) discussed that studied various forecasting model for fashion color trend. It includes ARIMA, the ANN family model (), (GM, GNNM, and Improved GM), and new method called GRA–ELM are included in the analysis of the fashion color trend forecasting. For his new Mixed GRA-ELM prediction model proposed, which is constructed by the GRA method using the input parameter selection phase. That Then select the parameters are fed into neural network as ELM enter. In the final prediction method by the GRA-ELM by the ELM. Real employment (and publicly available) data sets. In author analysis, his study showed for the fashion forecast Color trends, GM could not produce the ideal family model predictions accuracy. Family artificial neural network model is often in a better prediction. He studied all models accuracy. His new Proposed hybrid method GRA-ELM to achieve good prediction Precision, drawbacks can be avoided when consumed ANN. Therefore, he believed that this is a promising method for conducting Time is highly unpredictable and unstable prediction Series of fashion color trends.

4. Proposed methodology

Data Collection

The overall the procedure of this research is to collect the data of different sources like EDI (Electronic Data Interchange), Excel, Ladder Plan, Customers stores data. Using these methods we have collected weekly sales data to predict future sales. There are many attributes of data that include week, year and sale quantity.

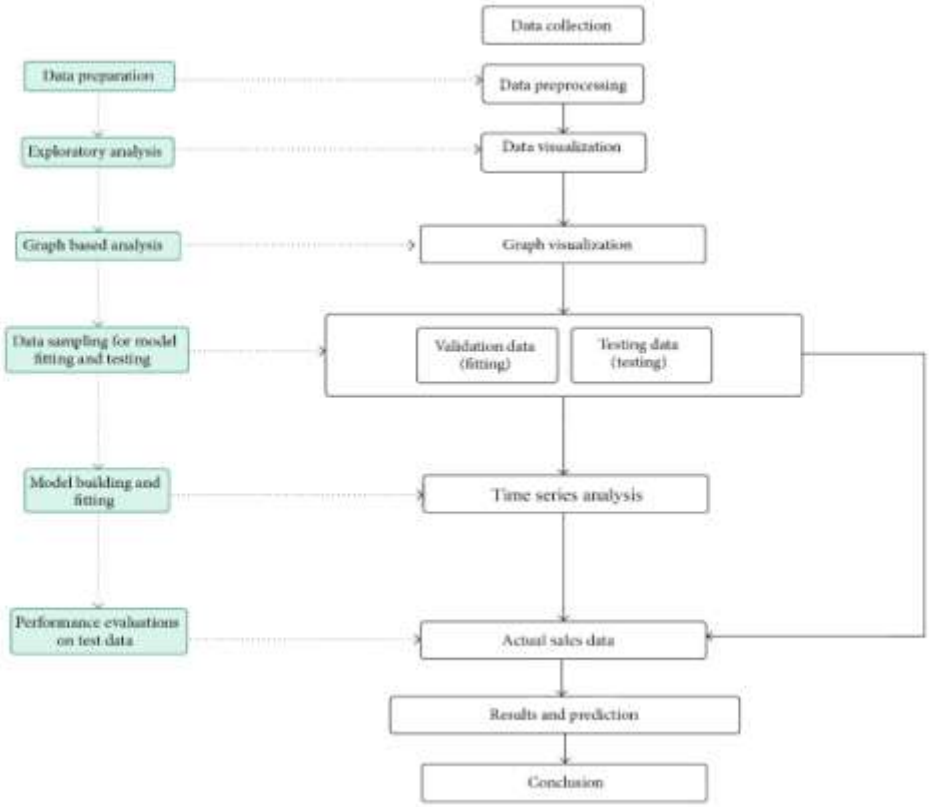

Fig. 1. Proposed methodology

Data Processing

After collection of data, data pre-processing has been applied. There are various techniques that have been used for this purpose.

Data cleaning is used to fill the missing value, identify and remove outliers. This is necessary to smooth the data.

Data has been collected from various sources e.g. ladder plan, EDI. So data integration has been applied to merge the data.

Exploratory Analysis

After data pre-processing, to better understand of data, it is necessary to implement exploratory analysis. It consists of below steps.

Graph based visualization

To see the impact of graphical, graph based visualization has been applied. In this way we can easily understand the comparison of actual quantity and projected quantity.

Model Building

Time series analysis has been used to build this mode. There are many technique used in time series. It includes

1. Regression
2. Seasonal Index
3. Quarter Moving Average

5. Results and discussion

2012	Q1	Q2	Q3	Q4
W1	1840	3278	3667	1988
W2	2322	3219	4006	2525
W3	2366	3186	4243	2307
W4	2454	3718	3664	3527
W5	2363	3924	3954	3174
W6	2429	3427	3729	3723
W7	2647	5257	2799	4468
W8	2969	4390	2674	7261
W9	2649	3867	2507	5530
W10	3013	4849	2528	3163
W11	2262	4070	2424	2360
W12	2901	3787	2588	2201
W13	3552	3367	2244	2229

Fig. 2. Raw Data of 2012

2013	Q1	Q2	Q3	Q4
W1	2037	3392	3938	2253
W2	3053	3095	3890	2200
W3	2876	3235	3515	2448
W4	2549	3426	3339	3511
W5	2575	3477	3720	3258
W6	2881	5539	2548	4056
W7	2781	4243	2605	6070
W8	2924	3960	2370	6943
W9	2415	4442	2421	3529
W10	2976	3945	2520	2082
W11	3073	4005	2512	2236
W12	3732	3746	2375	2112
W13	3696	3542	2100	1911

Fig. 3. Raw Data of 2013

2014	Q1	Q2	Q3	Q4
W1	1976	3314	4006	2383
W2	2697	3463	4250	2383
W3	2630	3432	3747	2362
W4	2340	3465	3974	3311
W5	2468	4124	4180	3178
W6	2728	5933	2984	3758
W7	2744	4150	2773	6048
W8	2451	3884	2742	6633
W9	2623	4162	2556	3598
W10	2698	4185	2562	2119
W11	3166	3637	2533	2005
W12	2600	4000	2332	1908
W13	3206	3943	2273	1879

Fig. 4. Raw Data of 2013

In result section, I describe last three years sales data (week and year wise). Which has been shown in below table. These data has been shown after pre-processing. Different comparison have been made with actual data and projected data including week level prediction, color level prediction and size level prediction for all quarters.

Apparel industries are facing different types of challenge's in which one challenge is to get accurate and detailed forecasted data like SKU wise sale data which actually means Size wise data for example Large, Medium, Small and in Large color may be Red, Green or blue what so ever.

There are different customers belongs to different suppliers in apparel industry and each supplier's try's to suggest the exact demand forecast that a customer would need, using customers previous purchase orders or history, now to achieve this task there is a need for a detailed and an accurate forecasting model which would fulfill the requirements of suppliers with respect to different aspects like Week wise forecasting, Size wise forecasting of data using previous quarter data.

To address SKU wise data forecasting there are many solution available which are purposed by different authors but each defined theory have different pros and cons to cater the problem. In many papers different theories are used to address SKU wise challenge but it is very difficult to implement purposed theories practically,. If someone got success by implementing theory have limited to quarter wise data. Quarter wise data prediction means no SKU wise data detail, no color or size wise detailed forecast data just showing quarterly total sales. So proposed model is predicting data at all level.

In this paper, we tried to cover different back draws and complexities which are purposed by different authors to address the SKU wise data. We use different approach which gives accurate and detailed data as compared to other purposed models. For example in this paper the purposed theory gives SKU wise detailed data which is the core challenge to apparel industry. As other purposed models are giving quarterly forecasted data which is not sufficient to address customer's requirement while in this paper a detailed forecast of quarter data is given at SKU wise, Week wise, Color wise level. SKU wise data representing style, color and size wise detail of forecasted data while Color wise detail is describing sale with respect to color. Week wise detail is representing Week wise sale of forecasted data. There is many factors that affect the demand of product, how to handle these factors. This become another topic open for future research.

The testing data provided for methodology validation comprises of three years including 2012, 2013 and 2014. Each Year is subdivided into respective 4 quarters their weeks and Sale against each week. Each Quarter mean is calculated against weeks of that respective quarter $\frac{\Sigma Sales\ per\ Qarter}{Count\ of\ Quearter\ Sales}$. After Calculating mean value of each quarter, 4 quarter moving average is calculated by taking mean of each quarter and taking centered average of these quarters $\sum_{i=0}^{n} \frac{Qi+(Qi+1)+(Qi+2)+(Qi+3)}{4}$. After calculating 4 quarter moving average now we will calculate centric average against each 4 quarter moving average $\frac{Qk+(Qk+1)}{2}$. Now we calculate % sales of particular year by $\frac{\Sigma Sales\ per\ Qarter}{Count\ of\ Quearter\ Sales}$ / $\frac{Qk+(Qk+1)}{2}$. After these all calculation I calculate mean of each quarter and then calculate sum of these four quarter mean. By using sum of these for x quarter calculate ad-joint factor, and final calculate seasonal index of each quarter by multiplying x ad-joint factor value with mean of quarter value $\sum_{i=0}^{1}(\frac{\Sigma Sales\ per\ Qarter}{Count\ of\ Quearter\ Sales} / \frac{Qk+(Qk+1)}{2})$ * x ad-joint. Now we will find regression line to best fit our predictive analysis underlying model. Regression Equation(y) = a + bx , Slope(b) = (NΣXY - (ΣX)(ΣY)) / (NΣX2 - (ΣX)2) Intercept(a) = (ΣY - b(ΣX)) / N. Regression equation (y= a + bx) need some previous calculated value for calculation of y value. I have calculated already some values from history data in previous steps, now I calculate sum of X, sum of Y, sum of XY, sum of XX, mean of X, mean of Y, a and b values, put these values into regression equation (y= a + bx) and calculate final result of regression equation.

I have also calculated week wise quantity comparison and size wise analysis from previous history data and find results of forecast values, generate the graph from these calculated results and show into report.

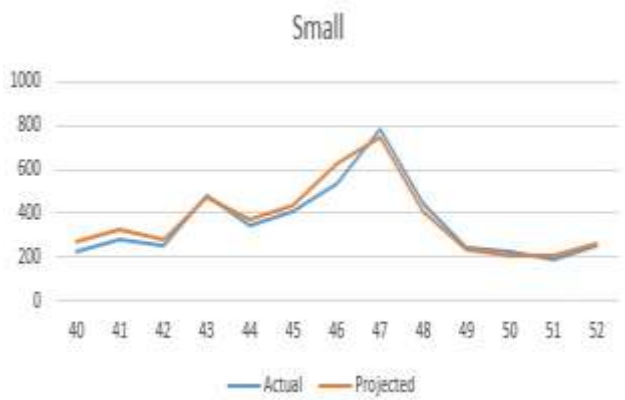

Fig. 5. Sale Graph of Small Size

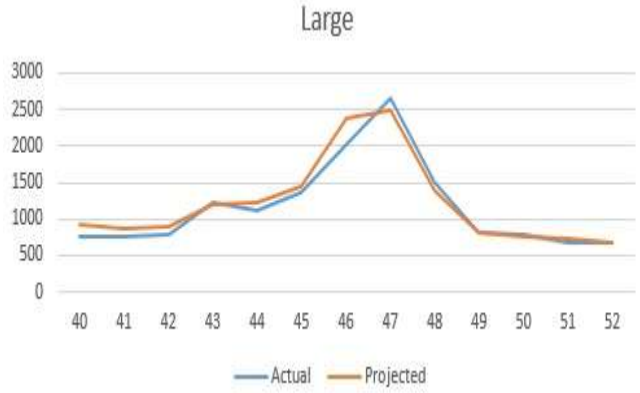

Fig. 6. Sale Graph of Large Size

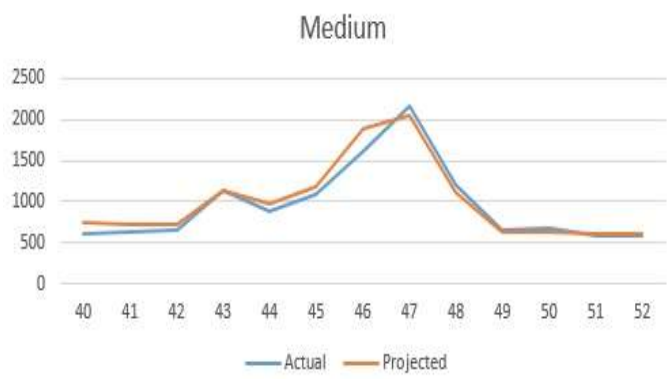

Fig. 7. Sale Graph of Medium Size

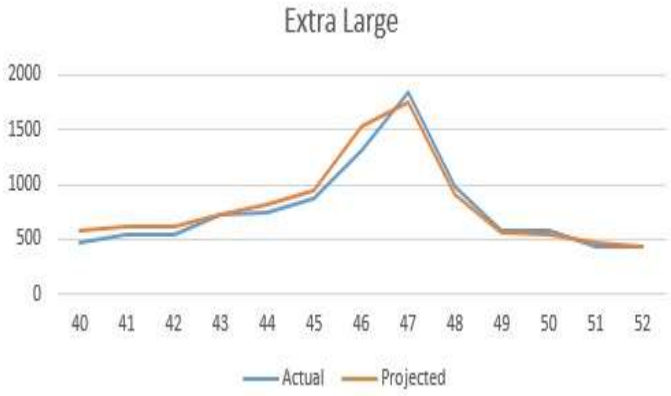

Fig. 8. Sale Graph of Extra Large Size

6. Conclusion

Now business type and model have been changed completely. The customer always wants that all things should be done by the supplier. In this way supplier has to manage his inventory on behalf of customer. So he is very keen to find a model whose support is to manage his inventory at SKU level. This model helps him to manage his stock at SKU level. In this model various experiments have been deployed that prove good results. But still there are some rooms that have been improved, like handle some external factors.

References

[1] Aburto, L. and R. Weber (2007). "Improved supply chain management based on hybrid demand forecasts." Applied Soft Computing 7(1): 136-144.

[2] Bartezzaghi, E., R. Verganti and G. Zotteri (1999). "A simulation framework for forecasting uncertain lumpy demand." International Journal of Production Economics 59(1): 499-510.

[3] Brown, R. G. (1959). "Statistical forecasting for inventory control."

[4] Chande, D. D. and M. Vijayalakshmi (2013). "Classification based Expert Selection for Accurate Sales Forecasting." International Journal of Computer Applications 61(12).

[5] Chatfield, C. (1988). "What is the 'best'method of forecasting?" Journal of Applied Statistics 15(1): 19-38.

[6] Chen, F. and T. Ou (2011). "Sales forecasting system based on Gray extreme learning machine with Taguchi method in retail industry." Expert Systems with Applications 38(3): 1336-1345.

[7] Choi, T.-M., C.-L. Hui, N. Liu, S.-F. Ng and Y. Yu (2014). "Fast fashion sales forecasting with limited data and time." Decision Support Systems 59: 84-92.

[8] Choi, T.-M., C.-L. Hui, S.-F. Ng and Y. Yu (2012). "Color trend forecasting of fashionable products with very few historical data." IEEE Transactions on Systems, Man, and Cybernetics, Part C (Applications and Reviews) 42(6): 1003-1010.

[9] Choi, T.-M., Y. Yu and K.-F. Au (2011). "A hybrid SARIMA wavelet transform method for sales forecasting." Decision Support Systems 51(1): 130-140.

[10] Di Martino, F., V. Loia and S. Sessa (2011). "Fuzzy transforms method in prediction data analysis." Fuzzy Sets and Systems 180(1): 146-163.

[11] Frank, C., A. Garg, L. Sztandera and A. Raheja (2003). "Forecasting women's apparel sales using mathematical modeling." International Journal of Clothing Science and Technology 15(2): 107-125.

[12] Fumi, A., A. Pepe, L. Scarabotti and M. M. Schiraldi (2013). "Fourier analysis for demand forecasting in a fashion company." International Journal of Engineering Business Management 5.

[13] Huang, G.-B., Q.-Y. Zhu and C.-K. Siew (2006). "Extreme learning machine: theory and applications." Neurocomputing 70(1): 489-501.

[14] Inaba, T. (2012). "Inventory management of short lifecycle slow moving items: a case study." International Journal of Logistics Systems and Management 13(1): 17-34.

[15] Lee, H. L. (2002). "Aligning supply chain strategies with product uncertainties." California management review 44(3): 105-119.

[16] Lee, W. I., B. Y. Shih and C. Y. Chen (2012). "A hybrid artificial intelligence sales-forecasting system in the convenience store industry." Human Factors and Ergonomics in Manufacturing & Service Industries 22(3): 188-196.

[17] Liu, H. (2015). "Forecasting Model of Supply Chain Management Based on Neural Network."

[18] Liu, N., S. Ren, T.-M. Choi, C.-L. Hui and S.-F. Ng (2013). "Sales forecasting for fashion retailing service industry: a review." Mathematical Problems in Engineering 2013.

[19] McKenzie, E. (1984). "General exponential smoothing and the equivalent

ARMA process." Journal of Forecasting 3(3): 333-344.

[20] Mostard, J., R. Teunter and R. De Koster (2011). "Forecasting demand for single-period products: A case study in the apparel industry." European Journal of Operational Research 211(1): 139-147.

[21] Nenni, M. E., L. Giustiniano and L. Pirolo (2013). "Demand forecasting in the fashion industry: a review." International Journal of Engineering Business Management 5.

[22] Ni, Y. and F. Fan (2011). "A two-stage dynamic sales forecasting model for the fashion retail." Expert Systems with Applications 38(3): 1529-1536.

[23] Omar, H., V. H. Hoang and D.-R. Liu (2016). "A Hybrid Neural Network Model for Sales Forecasting Based on ARIMA and Search Popularity of Article Titles." Computational Intelligence and Neuroscience 2016.

[24] Paliwal, M. and U. A. Kumar (2009). "Neural networks and statistical techniques: A review of applications." Expert systems with applications 36(1): 2-17.

[25] Pan, F., H. Zhang and M. Xia (2009). A hybrid time-series forecasting model using extreme learning machines. Intelligent Computation Technology and Automation, 2009. ICICTA'09. Second International Conference on, IEEE.

[26] Sfetsos, A. and C. Siriopoulos (2004). "Time series forecasting with a hybrid clustering scheme and pattern recognition." IEEE Transactions on Systems, Man, and Cybernetics-Part A: Systems and Humans 34(3): 399-405.

[27] Soni, G. and R. Kodali (2010). "Internal benchmarking for assessment of supply chain performance." Benchmarking: An International Journal 17(1): 44-76.

[28] Teucke, M., A. Ait-Alla, N. El-Berishy, S. Beheshti-Kashi and M. Lütjen (2016). Forecasting of seasonal apparel products. Dynamics in Logistics, Springer: 633-642.

[29] Thomassey, S. (2010). "Sales forecasts in clothing industry: The key success factor of the supply chain management." International Journal of Production Economics 128(2): 470-483.

[30] Varghese, V. and M. Rossetti (2008). A parametric bootstrapping approach to forecast intermittent demand. IIE Annual Conference. Proceedings, Institute of Industrial Engineers-Publisher.

[31] Wu, Q. (2010). "The hybrid forecasting model based on chaotic mapping, genetic algorithm and support vector machine." Expert Systems with Applications 37(2): 1776-1783.

[32] Yi, C. Y., E. Ngai and K. Moon (2011). "Supply chain flexibility in an uncertain environment: exploratory findings from five case studies." Supply Chain Management: An International Journal 16(4): 271-283.

[33] Yu, Y., T.-M. Choi and C.-L. Hui (2012). "An intelligent quick prediction algorithm with applications in industrial control and loading problems." IEEE Transactions on Automation Science and Engineering 9(2): 276-287.

[34] Yu, Y., C.-L. Hui and T.-M. Choi (2012). "An empirical study of intelligent expert systems on forecasting of fashion color trend." Expert Systems with Applications 39(4): 4383-4389.

[35] Zhang, G. P. (2003). "Time series forecasting using a hybrid ARIMA and neural network model." Neurocomputing 50: 159-175.

[36] Zhu, Q.-Y., A. K. Qin, P. N. Suganthan and G.-B. Huang (2005). "Evolutionary extreme learning machine." Pattern recognition 38(10): 1759-1763.