Up-on Fashion: A Trend Forecasting System on Customer Behavior
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R. N. Yapa, S. I. Bandara and C. D. Manawadu

Abstract—Fashion industry has significantly evolved, particularly over the past few decades forming a considerable impact on customers. In times of economic instability, it’s more important to forecast accurate, well informed trends. The purpose of this research is to investigate the fashion trend variations in reference to customer behavior in clothes and footwear shopping to help fashion retailers and brands build commercially successful and inspiring product ranges. According to the experiences gathered from the salespersons of fashion stores, each time a customer goes into a fitting room, a percentage of items carried in will be left out and only a few will be selected. The fashion industry is required to consider how the customers think, feel so that it helps the fashion stores in order to sell appropriate products, at the appropriate time and in the appropriate manner. Since the trend directions are underpinned with social and cultural attributes, it is more important to collect and analyze this information into a workable state. In this study the relationship between number of fittings and number of left outs based on the color, size, shape and the brand will be researched in order to forecast the seasonal trends and the number of sales in the next term. The end product or the software to be developed will be ultimately beneficial to the store management, consumers and to the entire fashion industry.

Keywords—Data Mining, RFID, Fast Fashion, Time Series, Sales in the next term, Consumer Behavior with Fashion

I. INTRODUCTION

Ever since the economy became more global, consumers are being heavily affected by the fast evolving fashion industry. Fashion reflects society and culture, likewise it reflects how people define themselves. People tend to equate fashion with clothing and accessories even though fashion processes affect all types of cultural phenomena.

Elizabeth [1] says Customers who try on clothes in fitting rooms have a conversion rate—meaning they ultimately buy something they tried on—of 67%, according to retail consultant Envision Retail Ltd., of Surrey, England, based on observations of more than 8,000 shoppers. Customers who don’t use the fitting rooms have only a 10% conversion rate. Shoppers who use the fitting rooms spend one third of their in-store time there. Maryam [2] says “when we take into account that the fitting room is usually the least attractive part of the store and retailers allocate fully 20 percent of their total space to fitting rooms, it’s even more critical to consumer decision making and retailer investment”. And also she indicates that equipping fitting rooms with interactive technology could drive customer satisfaction and increase purchasing for stores.

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A flat screen in the fitting room could be used to scan barcodes and find sizes needed so that sales representatives could bring them to shoppers in rooms. If sizes were unavailable in-store, the same touch screen could offer shipping to your home or indicate another store with the needed size.

In the case of items dealt with apparel shops, the number of specific items sold in a specific day at most is one or two. It is a tough task for the managers of apparel and footwear companies to decide the number of items ordered in the present term. This is because their mistaken decision leads to the decrease of returns by discount sales of remaining items and lost chance for sales. It is important to appropriately order the items. Today apparel industry faces a vast problem due to rejected item by customers. Because of this, fashion stores suffer a huge loss each year. When a customer visits a fashion store he/she selects so many patterns to be checked in the fit room. But after the fit on he/she selects a minimum number of outfits and rejects other items. Thus to identify the reason for this fashion rejection is the main problem in this research.

Today most of the fashion stores do their predictions manually. Most of the time they use Microsoft Excel for their predictions [3]. Currently chain owners are unable to detect rejected items and do predictions as there is no fitting system which satisfies their requirements. Microsoft Excel always does not provide a correct prediction and they face a big problem due to lack of accuracy. Even though the store management analyses the sales month wise, with the use of stock details, still they are unable to predict the forthcoming sales with respect to particular attributes such as color, size of outfits. Because of all these reasons they are facing huge problems.

In this research project, the team will produce a full functional system for trend forecasting. To overcome this problem the team will use RFID technology and Data Mining technology. The team planned to gather information on rejected items using RFID (Radio-frequency identification). Then Data Mining technology was used to find the patterns of rejected items.

Apparel industry worldwide is facing a colossal problem in handling the number of rejected garments, to find out the patterns by the customers after they try out the garment in a fitting room. Currently there is a dearth of research done in con-
sumer behavior with relevance to fitting rooms in fashion stores.

According to the reviews and experiences, each time a customer goes into a fitting room, a percentage of items he/she carries in will be left out and only few will be selected. The surveys done have figured out many reasons for this item rejection. The color, material, shape and the price have been identified as the main causes for rejection. But still the causes are assumptions made by the management of different stores worldwide and all the decisions taken are personally biased.

The pattern of purchasing trends cannot be identified by the prevailing systems. Many outfits get rejected by customers without a proper reason. Fashion stores are unable to meet the customers’ needs and customers will have a negative attitude towards the store. Another drawback identified is that the sales managers are unable to predict the most selling items beforehand without a proper analyzing method. Moreover there is no existing system to tackle the number of rejections after tryouts. So considering all these justified issues, as an approach to solve these mentioned drawbacks and hitches, a trend forecasting system will be delivered for the benefit of the apparel industry.

The research questions addressed via the study were:

1. How to gather information from an item about location and item name by using RFID and then store it in a database?
2. How to get the customer feedback about a particular item such as why he/she purchased it or rejected?
3. What kind of a data set do we need to analyze and make predictions?
4. What is the best data mining algorithm that can be used for trend forecasting?
5. What is the theoretical framework used to monitor customer behavior?

Outline the rest of this paper is organized as follows: Section II discusses background and related work; Section III explains in detail about the methodology. Section IV describes the results and evaluates of the techniques used; Section V concludes the research work and points out potential future work that can built and improved upon the work presented here.

II. LITERATURE REVIEW

Since this research is based on fast-fashion, RFID data, statistics and data mining techniques of the background study covers previous contribution of the authors and existing systems.

Owing to the progress of RFID readers and tags, it is possible to easily bury them in various objects and places. Toshiba Research Corporation [12] has proposed a new method that efficiently uses the RFID data collected from apparel shops. They have collected large amount of RFID data from sensor networks that can be used to help their decision making in various situations. High needs that should be speedily accessed and appropriately analyzed can be applied with various methods to activate the aggressively studied RFID data.

Like other industries, textile production systems have become more complex because of the various composite fibers, most technologically advanced equipment and due to relatively high capital investment. Therefore, the data from textile production is numerous, and often it is dynamically changed along the textile process chain. With traditional process decision methods, a huge mass of computation has to be repeated but product quality control is getting more and more complex. Zhi-Jun Lv’s research investigates the complete data mining methods from the industrial database, and presents a novel data mining based intelligent model (DMIM) forworst process decisions[13]. Considering a huge mass of data from textile production and inspection, as well as the variety of knowledge and experience from domain experts, they present a DMIM simulating, how domain experts routinely solve problems in a worsted process, through an integral application of case-based reasoning and artificial neural network techniques.

A case study approach was used to explore the adoption of RFID-based garment manufacturing information system in a garment factory in China. The findings indicate that both the ‘technology push factors’ and ‘need pull factors’ influence the intention of the garment factory to adopt RFID technology. Technology push factors include relative advantage, compatibility, complexity, extendibility, and cost of the technology while need pull factors comprise of competitors and customers pressure. Ngai[14] has identified eight factors for successful adoption of the RFID-based garment manufacturing information system, namely vendor selection, organizational motivation, cost/benefits evaluation, top management support, user involvement, extent of progress supervision, staff competence and training and policy, structure and operation process compatibility.

Information technology is used to link all the modern processes and manufacturing processes, which run in several layers coming from the boardroom to the shop floor. Kim[15] has introduced the manufacturing execution system (MES) which controls the operations that enable realization of the plans, close the gap by providing links among shop floor instrumentation, control hardware, planning and control systems, process engineering, production execution, the sales force and customers. In this research, the proposed system was established to actualize an overall inspection system for electronic components or devices using RFID. This study developed a system to inspect electronic components and devices, specifically, LCDs Panels that are the core parts of an LCD monitor store inspection result data in the RFID TAG and the Reader/Writer. As a result of implementing the system developed in this research, the inspection time in the real parts inspection line was greatly reduced. The system developed consists in a way that the inspection data of multiple types of parts or devices can be displayed in real time to raise the efficiency of the concerned inspector or manager.
Automated Identification and in particular, Radio Frequency Identification (RFID) promises to assist with the automation of mass customized production processes by simplifying the retrieval, tracking and usage of highly specialized components. RFID has long been used to gather a history or trace of object movements, but its use as an integral part of the automated control process is yet to be fully exploited. Such (automated) use places stringent demands on the quality of the sensor data collected and the method used to interpret that data. In particular, this research [16] focuses on the issue of correctly identifying, tracking and dealing with aggregated objects in customized production with the use of RFID. In particular, this work presents approaches for making best use of RFID data in this context. The presented approach is evaluated in the context of a laboratory manufacturing system that produces customized gift boxes.

In the apparel market and production, RFID has significant features and benefits over the traditional bar code. In product detail, the RFID chip can go as deep as storing information on name, model, color, size, and even the manufacturing location. A wider array of information can be stored in the tag. A key term to acknowledge with the technology is the unique EPC-code in the chip. With the EPC-code the product is one of a kind and the chip cannot be duplicated, making the authenticated product ever harder to copy. RFID chips are a great way to fight off counterfeiting as items can be tagged and read later on when determining authenticity. As each item is unique due to the RFID tags EPC-code, the individual product movement data can help in analyzing various aspects of consumer behavior, or even market demographics. The trying on data from the fitting rooms, such as the tried on different sizes, colors and models can ultimately give valuable information into which sort of direction modern trends are heading.

There is an existing research on an application of RFID to an apparel field which proposes a new method that efficiently uses RFID data collected from apparel shops. This research contains a very theoretical analysis on RFID data and it has introduced a prediction algorithm by applying them to a model based on the epsilon-Support Vector Mechanic [12].

There are also some application examples of RFID readers and the RFID tags in real world environments. Wal-Mart [18], Metro group [19], and Marks & Spencer [20] introduce them to efficiently manage items processed in the supply chain. Here, Wal-Mart is the biggest supermarket company in the world and the headquarters is located in the USA. Metro group is one of famous companies in the retail field and mainly performs the business in the Europe. Marks & Spencer is the biggest retailer in the UK. In addition, some experiments in the publisher field and the apparel field are performed in Japan. Mitsukoshi, one of famous department stores in Japan, introduces the RFID readers and the RFID tags at the apparel shop dealing with imported casual items. It operates them in daily business. The application examples show that the RFID readers and the RFID tags can decrease the management cost of the stock.

Table 1: Existing Systems Vs. Up-on Fashion

<table>
<thead>
<tr>
<th>Feature</th>
<th>System A</th>
<th>System B</th>
<th>System C</th>
<th>Out System</th>
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<tbody>
<tr>
<td>Locate Items</td>
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<td>Get Item Details</td>
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<td>Use For Security</td>
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<td>Data Mining</td>
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<td>Make Predictions</td>
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<td>Identify Most Selling Items</td>
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<td>Identify Rejected Items</td>
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<td>Analysis Customer Behaviour</td>
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<td>Mobile Application</td>
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<td>Access System Remotely</td>
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<td>View Sales Reports</td>
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<td>Schedule Predictions</td>
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<td>Check Feedback</td>
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<td>Web Application</td>
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<td>PDA Device</td>
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Table 1 portraits a comparison among the existing systems System A [17], System B [12], System C [14] and the Up-on Fashion System. The specialty of this research is the focus on customer behavior and fitting room routines to collect data for a prediction model. In this case the project is leading to get a commercial benefitted output using RFID technology and Data mining prediction models. Apparel and footwear fields deal with items whose prices are comparatively expensive and which many people buy in daily living. This research focuses on a method that predicts the number of items ordered in the present term by using the relationships between actions of customers and the number of sales in the next term.

III. METHODOLOGY

The aim of this research is to conduct a thorough study on trend forecasting system based on customer behavior. The paper describes the issues of current apparel field and introduces a set of new methods which can be used for the betterment of the industry. In conducting this research, both primary and secondary data were used. The primary data are gathered from the online survey conducted to gather customer feedback. It was designed in the manner where the user group is eligible to understand, to distribute among people who are familiar with purchasing attire after trying out in the fitting room. The survey is mainly focused on “How the Fitting Rooms and Customer Behavior Will Benefit in Predicting Sales in The Next Term.”

The secondary data, all of which is marked as reference sources already exists on internet and related books. As secondary data the team collected relevant information from a renowned store, from their system database for a period of 4 months, from 26th April-14th September 2013 with authority. Due to security concerns and confidential matters it was unable to disclose the store which the data was gathered. Since the research is based on data mining and prediction analysis, sales data containing multiple independent variables is being used in a multivariable data mining time series algorithm. A sample of the sales data format is shown in table 2.
Date, ItemID, Name, Color, Design, Material, Size, Details (Length, Neck, Sleeve, and Waist), Reject Count and Sold Count of each item were collected for the dataset. ItemID is the unique key field and date field is added to recognize the sales/rejections per the given date. Name indicates the item type such as pants, skirts or shirts and design describes further details of the attire. Reject count and sold count are calculated per day and they will be used to manipulate the predictions and forecasts.

There are two data sets which were used in order to acquire predictions via prediction models.

1. “Sales” dataset
2. “Rejections” dataset

Details on sales and rejections are inserted into the time series prediction model for analysis. Forecasting on Sales and Rejections are the two main categories. There are few forecasting models developed such as Category forecast model, color forecast model, material forecast model, design/style forecast model and advanced forecast model to forecast by sales and rejections. The desktop application with the analysis, forecasting and prediction functions, the mobile application for the managers and sales assistants and the touch panel in fitting rooms for the customers are the main components of this research.

IV. RESULTS AND DISCUSSION

This section of the research paper will describe the research outcomes based on the test cases, prediction results, data collecting & prediction models and developed software’s functionality. As mentioned in section III the team has successfully gathered the relevant data and created the appropriate datasets for the research trials to be done.

A. Creation of Data collecting Model & Prediction Model

Data which are to be analyzed through the algorithms should be 1st gathered in data models. Data collecting model consists of the details of the outfits with all the needed parameter values. At present the applicable data are manually entered whereas RFID technology will be used to capture the data after the system implementation via the RFID readers and tags. The RFID tags will be assigned to items and RFID readers will be placed in the stack areas, shelves, pick-up bags, fitting areas, rejection box and the cash registers. So the system will collect information related to sales, pick-up, fitting, stock and the number of rejections. RFID tags include data such like size, color, design, material and further details on sleeve style, neck style will also be monitored simultaneously.

The desktop system will use the collected data sets to acquire prediction models. The system will synchronize with the real time RFID data and according to the size, color, design and material the system will analyze the data in order to identify the relationship between the independent variables such as number of customers, stock, sales etc. in a week or a season and the dependent variable corresponds to the number of sales in the next week or the season.

B. Algorithms, Logics & Models

The main objective of the time series analysis is to model a process, which is generating the data, to provide compact description and to understand the generating process. Decomposition (pre-processing) and combining (post-processing) when applied on the time series result in improvement of the accuracy of forecasts. After decomposing the series statistical experts such as ARIMA [22, 23, and 24] are applied to get the forecasts of component series. Fig. 1 displays the data mining model structure of the research project.

C. Test cases, Predictions & Results

The research team focused on conducting a properly planned unit testing process in order to identify the errors so that the defects will not get affected in other phases of the Software Development Life Cycle. The test cases have been prepared and documented, with the intension to refer again in a regression testing phase. Test case scenarios for all the 3 main components(desktop application, mobile application, touch panel) are created and tested. The prepared test cases have been examined very carefully and have captured all the possible cases which can arise during the system execution. The below fragment of the table (table3) displays few conducted test cases.
Predictions are mostly based on the pattern of reject count and sold count. The data mining structures support in retrieving the forecasting and prediction results. Predictions will include: sales statistics, rejection statistics and the dependency between sales and rejections based on a particular item. Fig. 2 portrays the mining structure of the rejected count.

![Fig. 2: Forecasting Result Viewer: Desktop System](image)

Results include all the final outputs of predictions and forecasts. Prediction results are displayed via desktop application as well as through the mobile application. Predictions based on sales and rejections are forecasted founded on the different forecasting models. The accuracy rate of final decisions and predictions are considerably high. Fig.3 displays a sample accuracy report.

![Fig 3: Accuracy Chart](image)

Considering the cost effectiveness, a relatively high investment has to be made in order to place RFID readers and tags. But a huge sum of money will not be spent in the middle of business procedures and it will cover up the initial implementation cost. So this will be beneficial for an enterprise to establish with a considerate costing.

V. CONCLUSION AND FUTURE WORKS

The dissertation proposes a method that predicts the number of sales in the next term based on the RFID data. Also it evaluates its efficiency which is based on the data collected from a renowned fashion store. Up-On Fashion trend forecasting system provides an efficient, user friendly and an easy way of getting the predictions. Development team has made a tremendous effort in developing these features, because these are the most important components which make the project unique.

In future work, the team will work on the improvement of the prediction models with newly collected RFID data. These improvements of data can revise the models. The prediction based on the RFID data can be realized through the improvements. On the other hand, the team will aggressively make an effort in establishing many methods which the RFID data which can be efficiently activated in various fields.

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