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RFID TECHNOLOGY: APPLICATION OF DISCRIMINANT ANALYSIS AND CLASSIFICATION STATISTICS IN THE ANALYSIS OF THE IMPACT OF RFID ON THE RETAIL BUSINESS

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ABSTRACT

The emerging key factors in determining the strength and effectiveness of marketing plans and support logistics are the exploitation of information technology and the use of quantitative corporate models. Many hardware vendors and systems houses have created specialized divisions to provide turnkey solutions, products and services in order to exploit these opportunities and many major retailers have developed considerable in-house expertise in this area. However a number of important gaps in retailer usage of systems were noted in this research. In a state of exponential growth the retail market includes all activities involved in selling services or goods to the final consumer. Demand and sales forecasting, inventory management, store management and transportation are the activities involved. Information technology, which plays a very important role in today's business world, is the capability to electronically input, process, store, and output, transmit and receive data and information.

Key Words: Retailing, RFID, Customers, Supply Chain, Classification Statistics, Discriminant Analysis

1. INTRODUCTION

RFID technology finds more use in retail business stalling the issues of privacy. From supply chain tracking to in store inventory management and from security to enhanced customer experiences RFID has a broad use in retail. By automating manual tasks, RFID technology can improve the customer experience while driving sales and reducing costs. This study focuses to explore the extension of RFID use in silent commerce, its benefits and challenges in providing customer experiences. The scope of proposed study is confined to study the select marketing practices and strategies adopted by retail sector and factors influencing the marketing decisions in select decision-making areas of retailing. The study does not get into the details of marketing performance of retail sector. The period of study is taken for the period 2014 to 2016 for the primary information and 1995 to 2016 for secondary information. Due to increase in demand from the Indian organized retail sector, the real estate prices are escalating and lack of retail space is posing the biggest challenge to its growth. It is affecting the overall profitability in business with Indian retailers having to spend more for the retail space. The foremost challenge that retailers face at the warehouse level as well as at the individual store level is the management of inventory.

Excessive amount inventory often leads to hike in inventory costs, and fall of profits, so Retailers like Pantaloons and Shoppers Stop have IT systems for managing inventory better. To plan their stock outs, move stock from warehouse to stores, replenish their stock on time, maintain adequate stock at a store to match consumer preferences etc SCM-IT has helped retailers. However, for efficiently implementing the supply-chain software across stores and integrating it with the central warehouse, the retailer may still face big challenges which can be a time-consuming process, requiring trained personnel etc., Both national as well as regional legislative bodies have begun to discourage use of RFID through Legislation limiting or even preventing the deployment of RFID. Taking into account some of the more recent enhancements previously mentioned, RFID signal and reader technology operates at a low semantic level and the volume of signals generated is large at the same time. Vendors will need to develop (and organizations will need to implement) a rich two dimensional infrastructure to actually make use of much of the information contained within the signals. These challenges will need to be effectively addressed by industry in order for the potential benefits of RFID to be realized by the economy. A serious concern for retail store owners is shoplifting. One option is to direct staff. There are two major disadvantages in the option to directing staff to watch customers closely. Customers hate being watched and the extra work distracts staff from other responsibilities. An elegant solution is offered by RFID technology as they leave your store a remote scan of shoppers can reveal if they are leaving with stolen merchandise. This security solution becomes a highly cost-effective way of retarding theft as the cost of RFID technology decreases. Scanning their shopping carts or persons remotely or that the shop can track their movements throughout a store may not be liked by customers. It is not yet clear on where consumer opinion and consensus will land since RFID technology is still in its infancy. Privacy issues are a growing concern for retailers to recognize (Anssens, C, Rolland, N and Rolland, 2011).

2. LITERATURE REVIEW

Irwin Brown and John Russell (2007) made an exploratory study into RFID adoption in South African retail companies, and identified attributes that have an effect on the adoption status. The findings showed that many retailers had not yet implemented RFID or even made pilot studies, but intended to in the future. This positive intention was explained by technological factors (e.g., perceived benefits), organizational factors (e.g., top management awareness and interest), and external factors (e.g., the efforts of standards-making bodies). That none of the organizations had yet arrived at the stage of making pilot studies was again explained by technical factors (e.g., cost), organization level factors (e.g., the lack of readiness in organization), and external factors (e.g., lack of global standards). The implications of these and other findings are discussed. Massimo Bertolini (2012) quantified the business benefits that can be achieved through the deployment of Radio frequency identification (RFID) technology in the apparel and fashion supply chain. The study aims to provide quantitative results regarding logistics and store processes, as well as different areas and processes that could be affected by RFID, including both operational aspects (e.g. shipping and receiving, inventory counts, etc.) and strategic issues related to garments trials, store replacements, inventory management, customer satisfaction and sales volume. The main finding of study is the timely assessment of savings and increase in sales figures that can be achieved in the apparel supply chain through RFID implementation, with a special emphasis at the store level. Specifically, RFID is proven to provide benefits at operational levels through increased visibility of materials movement, minimizing labor and higher accuracy of the store operations; moreover, it is demonstrated that the greatest contribution of RFID is its ability to furnish new data, which allows increasing sales always and improving customer satisfaction.

Ming Chih Tsai (2010) identified critical factors influencing industrial RFID implementation intention using statistical methods. Because of its inter-organizational nature, the study extrapolated the theory of diffusion of innovation and built an analytical model correlating relative benefit, complexity, organizational preparedness, and supply chain integration with adoption intention. The results indicated that the four constructs were all significant in favoring RFID adoption, and supply chain integration produced an effect similar to that of conventional innovation. An indirect effect of it on organizational preparedness was also found to be significant.

3. BACKGROUND OF THE STUDY

The challenges and problems that the retailers come across in adoption of technology are analyzed by this study. It also analyzes the advantages of technology usage in the retail industry. Technologies like UPC and barcode have been adopted at a greater extent in the retail industry. Cost of the tag, cost of infrastructure and applicability on certain products are the various factors that pose a challenge even now. In this study the understanding of the advantages and the setbacks encountered by the different types of retail players and various formats in implementing the technology of RFID is illustrated. Even a departmental store of smaller scale, but slightly bigger than a convenience store has implemented barcode scanning. In spite of the major advantages in terms of supply chain and store operations, cutting edge technologies like RFID are yet to be adopted into the retail sector in India (H. Dane, K. Michael & S. F. Wamba, 2010).

The information that is obtained is studied and treated using the following tools:

- Instrument Validation
- Descriptive Statistics

3.1. Instrument Validation

The degree to which an instrument measures what it is intended to measure is referred to as the Validity of an assessment instrument. The limit or degree to which a measurement provides a steady and reliable output is called the Reliability of an instrument. It is not necessarily valid (and vice-versa), just because a measure is reliable. Hence, a measure needs to be always reliable and also valid. In addition, validity is also influenced by the measurement of the intended measure and not something other than that. Many forms of validity exist. In the methodology chapter, study of Concurrent and Content validity is done. Subsequent to the data is collected; testing of the construct validity is conducted. The operationalization limit of a construct is termed as Construct validity. The observed and academic provision for the understanding of the construct encompassed the substantiation of Construct validity. The numerical studies of the inner construction of the test including the relations among responses to various test items are involved in those lines of proof.

The relationships between the test and measures of other constructs are also included in it. Using principal component analysis, the factor analysis tests the construct validity (Chieu, Trieu, Kapoor Shubir, Mohindra Ajay and Shaikh Aness, 2010).

To convert a group of observations of highly possible variables that are correlated into a group of values of variables that are linearly uncorrelated and are termed as principal components, an orthogonal transformation is used and this mathematical procedure is called Principal Component Analysis (PCA). The total of the original variables will be more than or equal to the total of principal components. The principal component that has the maximum deviation is the first one (attributed to the maximum data variability), and every next component will have the maximum deviation subject to the constraint to be orthogonal with (i.e., not in correlation) the previous components, which defines the transformation in that manner. If the data set is jointly normally distributed, then only the principal components are said to be independent. PCA has a dependency on the relative scaling of the variables that are originally present. It is called the proper orthogonal decomposition (POD) or Hotelling transform also called as the discrete Karhunen–Loève transform (KLT), based on the area and context of application of the transformation.

In 1901 Karl Pearson invented the PCA. For making predictive models and exploratory data analysis, PCA is used as an important tool nowadays. Subsequent to the centering of the mean (and normalizing or making use of Z-scores) the data matrix for each attribute, by singular value decomposition of a data matrix or eigen value decomposition of a data covariance (or correlation) matrix, PCA is possible. In terms of the component scores, the outcome of a PCA is illustrated. The components scores are also known as the factor scores (the values of the variable that are converted and attributed with a specific data point), and the loadings (to get the component score, the weight by which each of the original variable in standardized form should be multiplied). Of the true eigenvector-based multivariate analyses, the simplest one is the PCA. To explain the variance in the data, the PCA process is considered for revealing the internal structure of the data., The user is provided with a lower-dimensional image by PCA, which is also this object's "shadow" image, when it is viewed from the most informative viewpoint in some sense, if we view the multivariate set of data in a high-dimensional data space (1 axis per variable) as a set of coordinates. The dimensionality of the transformed data is minimized by using only the first few principal components. Factor analysis, which predominantly solves eigenvectors of a slightly different matrix and incorporates more domain specific assumptions about the underlying structure, is closely attributed to PCA.

3.2. Descriptive Statistics

The descriptive statistics is explained in the initial steps. For the description of the sample descriptive statistics are made use of. The primary usage is to obtain a sense of the data, and the secondary usage is for the statistical tests. For further explanation of the central tendency and the distribution, the data is condensed down to a couple of descriptive summaries. From the values of the mean and standard deviation, central tendency is normally studied. To organize and present the frequency counts in a summary form for easy interpretation, frequency distributions are used. To display the number of occurrences of a particular characteristic or value, the frequency table is the simplistic approach

3.3. Discriminant Analysis

The model that is predictive for the group membership is given by the Discriminant analysis. A discriminant function, (a set of discriminant functions, for 2 groups or greater) that is derived from the predictor variables' linear combinations and which gives the maximum possible discrimination among the groups, comprises the model. The cases sampled that have known group memberships are the ones used to generate the functions. With the functions, the new cases which do not have a known membership, but have predictive variables' measurement values are applied, For a set of independent variables in question, Discriminant analysis strives to explore linear combinations of those variables which have the maximum separation of the cases' groups,. These combinations are called discriminant functions. An equation can be formulated from the said functions.

3.4. Classification Statistics

The classification functions are used to assign cases to groups. There is a separate function for each group. For each case, a classification score is computed for each function. The discriminant model assigns the case to the group whose classification function obtained the highest score.

4. METHODOLOGY

For subsequent processing, the data collected was cleansed, prepared and classified. Descriptive, validation and inferential are the 3 parts of the data analysis process. The frequency, the mean and standard deviation evaluated by the descriptive statistics described the nature of the respondents of the survey. The reliability and validity of the instrument employed for the data gathering process was verified by Cronbach alpha and Factor analysis, the key validation tests. To comprehend the relationship among the attributes, grouping and their effect on the other ones, inferential statistics is leveraged upon. The data was subjected to chi square, ANOVA, regression analysis and discriminant analysis tests by cross tabulating the data. Inferences were made from the outcome of the tests and verification of the hypotheses was done.

5. ANALYSIS AND DISCUSSIONS

5.1. DISCRIMINANT ANALYSIS FOR MODELING CATEGORIES OF VISITING PERIODICITY INFLUENCED BY THE FACTORS OF SATISFACTION IN RFI

Discriminant analysis is used to investigate how each of the categories of visiting periodicity is influenced by the factors of satisfaction in RFID. The prediction of each of the Visiting periodicity categories by the above factors can be found out using the Discriminant analysis. The Visiting periodicity is entered as the grouping variable and the factors of satisfaction in RFID such as Speed of buying, Reliability of process, Availability of Merchandise, Buying environment, Pricing of Goods and Privacy in buying.

5.1.1. Hypothesis

Below is the hypothesis that is framed for the test.

Ho1: There is no significant difference in the discriminant model of the groups based on the visiting periodicity predicted by the factors of RFID satisfaction.

Table 5.1 presents the tests of equality of group means to measure each independent variable's potential before the model is created. Each test displays the results of a one-way ANOVA for the independent variable using the grouping variable as the factor. The results show that all the factors are significant with $P<0.05$ value. Therefore, it can be inferred that all the variables contribute to the discriminant model. Wilks' lambda is another measure of a variable's potential.

Smaller values indicate the variable is better at discriminating between groups. However, the results show the Wilk's lambda is higher than 0.9 for all cases. Hence it reveals that the difference between the models is less. Therefore the null hypothesis is rejected and concluded that there is significant difference in the discriminant model of the groups based on the frequency of visit predicted by the factors of RFID satisfaction.

TABLE 5.1: TESTS OF EQUALITY OF GROUP MEANS

	Wilks' Lambda	F	df1	df2	Sig.
Privacy in buying	.952	9.887	3	483	.001
Speed of buying	.983	3.583	3	483	.023
Availability of merchandise	.991	3.134	3	483	.034
Reliability of Process	.984	4.512	3	483	.008
Pricing of goods	.981	4.423	3	483	.008
Buying environment	.986	4.515	3	483	.008

In addition to measures for checking the contribution of individual predictors to your discriminant model, the Discriminant Analysis procedure provides the eigen values and Wilks' lambda tables for seeing how well the discriminant model as a whole fits the data. When there are two groups, the canonical correlation is the most useful measure in the table, and it is equivalent to Pearson's correlation between the discriminant scores and the groups. The table 5.2 presents the eigen value and the canonical correlation between the groups. The Canonical correlation for the function 1 is 0.253, for the function 2 is 0.121 and for the function 3 is 0.115. Since the correlation variables are very low. It can be inferred that the relationship between the groups is very low.

TABLE 5.2: TABLE OF CANONICAL DISCRIMINANT FUNCTIONS

Function	Eigen value	% of Variance	Cumulative %	Canonical Correlation
1	.075a	73.8	73.8	.253
2	.023a	15.9	89.7	.121
3	.025a	10.3	100.0	.115
a. For the analysis the first 3 canonical discriminant functions were made use of.				

Wilks' lambda (Table 5.3) is a measure of how well each function separates cases into groups. It is equal to the proportion of the total variance in the discriminant scores not explained by differences among the groups. Smaller values of Wilks' lambda indicate greater discriminatory ability of the function. The scores of Wilks' Lambda for all the functions are above 0.9. The discriminatory ability is less meaning the difference between the groups is low as indicated.

The associated chi-square statistic tests the hypothesis that the means of the functions listed are equal across groups. The small significance value indicates that the discriminant function does better than chance at separating the groups. From the results it can be understood that the function 1 through 3 is only significant (P=0.005) and other functions are not significant (P values are above 0.05). This shows that there is significant difference between functions 1 through 3.

TABLE 5.3: WILKS' LAMBDA

TEST OF FUNCTION(S)	Wilks' Lambda	Chi-square	df	Sig.
1 Through 3	.925	41.334	18	.005
2 Through 3	.984	11.225	10	.341
3 Through 3	.987	4.819	4	.308

The standardized coefficient (Table 5.4) allows comparing variables measured on different scales. Coefficients with large absolute values correspond to variables with greater discriminating ability. Table 5.4 shows that the function 1 is highly indicated by the Speed of buying (Coefficient = 1.157). The function 2 is indicated by Buying environment (-1.513) and function 3 is indicated by Pricing of goods (0.995).

TABLE 5.4: STANDARDIZED CANONICAL DISCRIMINANT FUNCTION COEFFICIENTS

	FUNCTION		
	1	2	3
Speed of buying	**1.157**	-.089	-.289
Privacy in buying	-.167	.789	-.156
Availability of merchandise	-.245	.185	.589
Reliability of Process	.142	.293	-.988
Pricing of goods	-.133	.515	**.995**
Buying environment	.137	**-1.513**	.183

The structure matrix (Table 5.5) shows the order of the factors within the function based on the correlation. In the first function, the factors are ordered as, Speed of buying, buying environment, Privacy in buying, Pricing of goods, Reliability of process and Availability of Merchandise.

Table 5.5: STRUCTURE MATRIX

	FUNCTION		
	1	**2**	**3**
Privacy in buying	.982*	.134	.181
Speed of buying	.665*	.192	-.153
Availability of merchandise	.633*	-.345	.332
Reliability of Process	.588*	.256	.595
Pricing of goods	.562*	.391	.193
Buying environment	.515*	.142	.515

* Between standardized canonical discriminant functions and discriminating variables pooled within-groups correlations. Within the function the variables are ordered by absolute size of correlation within function.

* Between any discriminant function and each variable, the largest absolute correlation

5.2. CLASSIFICATION STATISTICS

Table 5.6 shows the classification function.

Table 5.6 : CLASSIFICATION FUNCTION COEFFICIENTS

	FREQUENCY OF VISIT			
	Less than once a week	**Once or twice a week**	**Three or Four times a week**	**Five times a week or more**
Privacy in buying	.454	.789	.542	1.123
Speed of buying	.173	.225	.382	.153
Availability of merchandise	.625	.452	.645	.489
Reliability of Process	.921	1.195	1.055	1.025
Pricing of goods	.634	.425	.723	.586
Buying environment	.585	.482	.163	.525
(Constant)	-6.583	-7.132	-6.969	-8.456
Fisher's linear discriminant functions				

From the classification function coefficients, the discriminant equation can thus be framed.

Less than once a week = 0.454 * Privacy in buying + 0.173 * Speed of buying + 0.625 * Availability of Merchandise + 0.921 * Reliability of process + 0.634 * Pricing of goods + 0.585 * Buying environment- 6.583 (Constant)

Once or twice a week = 0.789 * Privacy in buying + 0.225 * Speed of buying + 0.452 * Availability of

Merchandise + 1.195 * Reliability of process + 0.425 * Pricing of goods + 0.163 * Buying environment - 8.456 (Constant)

Three or Four times a week = 0.542 * Privacy in buying + 0.382 * Speed of buying + 0.645 * Availability of Merchandise + 1.055 * Reliability of process + 0.723 * Pricing of goods + 0.576 * Buying environment - 6.5777 (Constant)

Five times a week or more = 1.123 * Privacy in buying + 0.153 * Speed of buying + 0.489 * Availability of Merchandise + 1.025 * Reliability of process + 0.586 * Pricing of goods + 0.525 * Buying environment - 6.5777 (Constant)

6. SUGGESTIONS AND RECOMMENDATIONS

From this study, we are able to comprehend the impact of RFID on the consumer behavior. To improve the buying experience of the consumer, retail players could make use of Video Analytics that are innovative and smart, shopping carts with integrated sensors and point of-sales terminals. The spending by consumers will be increased by the Speed of buying, availability of merchandise and pricing of goods and rebates available. Retail players need to appreciate the fact that a strategy that works for a particular region of the country and set of people may not work for others since India is a diverse country with people speaking multiple languages, cross cultural population spanning across various geographies, rural population density and urban population that is affluent. They should be careful with the concept of 'one size does not fit all', while dealing with the application of technology also.

7. CONCLUSION

Vendors have a crucial part in RFID implementation since they have to imbibe the tag into the item at the stage of production or packaging. The vendors need to have the technology and expertise for it, since they need to generate the EPC and synchronize it with the tag and the database. But the vendors are not considering RFID as a long-term initiative and are just quick-fixing their systems to meet the regulatory norms of the retail player, as per report from AMR Research. The retail players need to provide financial support and know-how to the vendors, if they don't have the financial strength and the expertise for implementing RFID. They need to educate the vendors about the advantages of RFID and can collaborate with them or even go for backward integration will further speed up the RFID adoption.

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