An Artificial Neural Network approach for predicting antecedents of m-commerce loyalty

ABSTRACT

The m-commerce market has been rapidly growing worldwide and especially in emerging market like India. With the increased competition in this market, it is highly important for marketers of mobile shopping applications to focus on customer loyalty and retention, in order to gain sustainable competitive advantage. The objective of this study is to identify the determinants of customer loyalty and explore the relative importance of these predictors. The study adopted a mixed approach for the purpose of testing the hypothesis i.e., multiple regression analysis (MRA) and artificial neural networks (ANNs). Data were collected, through online survey, from 535 mobile shopping customers in India, to empirically validate the proposed research framework. The results of MRA revealed that perceived risk, satisfaction, price saving orientation, perceived usefulness and perceived trust were having significant influence on customer loyalty, whereas the impact of hedonic motivation was insignificant. ANN technique measured both the linear and non-linear relationships of significant predictors and customer loyalty. Through ANN, it was found satisfaction was the most important factor in shaping the customer loyalty, followed by perceived risk, price saving orientation, perceived usefulness, and perceived trust. The uniqueness of this research in uncovering the predictors of m-commerce loyalty in India, one of the fastest growing markets in the world.

Keywords: artificial neural network, m-commerce, customer loyalty, satisfaction, perceived risk, price saving orientation

I. INTRODUCTION

The competitive landscape of m-commerce market in India has intensified in the recent past, facilitating availability of wider choices of products and services at attractive prices to the customers. In order to gain sustainable competitive advantage, the m-commerce firms should have a deeper understanding of how customers get satisfied with their shopping experience and remain loyal in the long-term. Although, the firms could attract more and more new customers, it is highly important to retain the existing customers. The direct and indirect benefits of retaining existing customers would outweigh the profits from the new ones. As popularly noted by Reichheld and Schefter (2000), the cost of attracting a new customer is five to ten times more than that of retaining an existing one. The mobile shopping applications provide many utilitarian benefits such as availability of information, convenience, comparison of product features and prices, and savings in time and cost. Similarly, they provide hedonic benefits such as aesthetic appeal, an attractive feel, entertainment, and enjoyment of shopping over a smartphone. The hedonic factors were found to be more relevant for the current customers of mobile shopping than the non-customers (Agrebi and Jallais 2015).

Currently, the mobile applications are developed with many attractive features and design keeping the users' experience in mind and mobile shopping apps are no exception to it. It has been noted that the mobile shopping applications, with an exclusive feature of mobility, can provide any time any place access to product information, discounts and offers to customers and this (location-based targeting) will help marketers to provide their customers a personalized and satisfying experience (Chopdar and Balakrishnan 2020). The e-commerce firms (e-tailers) in India have been offering heavy discounts and offers in order to make online channel more attractive and to increase the engagement, loyalty and retention of their customers. Although, the e-tailers were offering their services through websites and mobile apps, many of them encouraged their customers to use only apps by providing the promotional offers restricted to mobile platforms. As noted in the literature and practiced by firms, app-specific promotions have been effective in encouraging the customers to buy products and services on an impulsive basis (Ibid.). It is important to measure the impact of customers' motivation to purchase when discounts and offers are provided, on their loyalty (Yang et al. 2016).

It has been found that the customers' loyalty would increase when they are highly engaged in various activities of mobile shopping (Alalwan et al. 2020). Essentially, the mobile shopping applications to be made as user-friendly and attractive i.e., the marketers must focus on atmospherics. Further, as suggested by Bilgihan et al. (2016), the companies, while designing mobile applications, should emphasis on factors such as aesthetic design, simplicity in usage, perceived benefits, perceived enjoyment, utilitarian, and hedonistic features etc. to provide a delightful shopping experience to their customers. These factors were found to augment customer engagement and loyalty.

Mobile commerce – A revolution

With the rapid development of information and communication technologies in general and the Internet in particular, the opportunities for business growth across the globe has been exponentially increasing in the last three decades. Initially, the businesses used to create online websites for providing information about the products and services offered by them, which has transformed into a transactional platform later. In such e-commerce websites, customers used to buy their preferred choice of products and services through a personal computer from home or office. According to eMarketer (2022a), the retail e-commerce sales are expected to grow from $4,248 billion in 2020 $7,391 billion in 2025 (figure 1). Interestingly, the growth rate of e-commerce across the world is estimated to decrease to 9.2% in 2025 from 26.4% in 2020, due to the disruption of Covid-19 pandemic crisis and other global economic conditions. Further, the percentage of retail e-commerce sales worldwide to the total retail sales is expected to increase from 17.9% in 2020 to 23.6% in 2025.
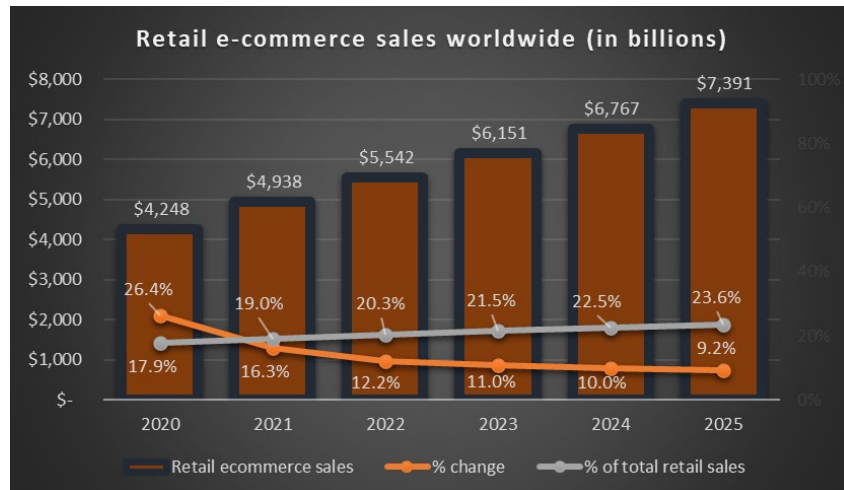

Figure 1: Retail e-commerce sales worldwide from 2020 to 2025 (in billions)

Primarily, the massive growth of e-commerce market was confined to developed countries such as the U.S., the U.K., Australia etc. But this trend has shifted towards the emerging markets in the last two decades (figure 2). As given in figure, Philippines, India, Indonesia, Brazil, Vietnam are the top five countries leading the retail e-commerce sales growth worldwide in 2021 (eMarketer, 2022b).
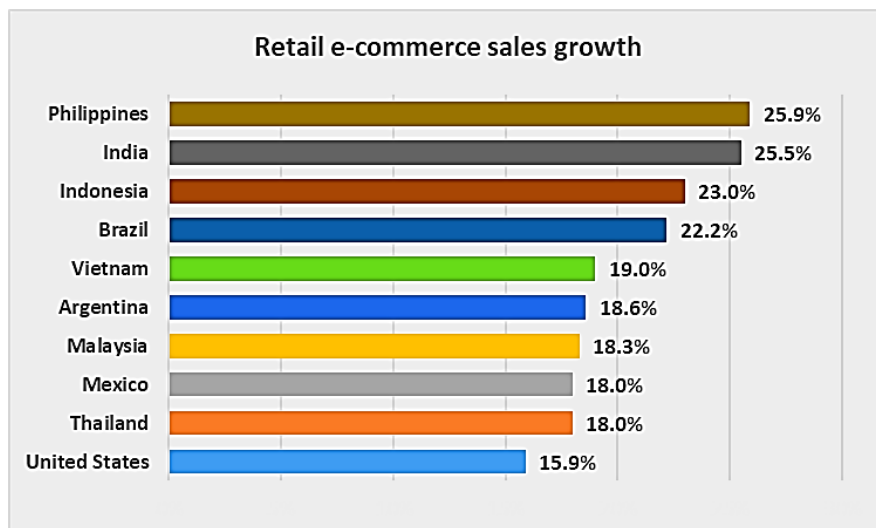

Figure 2: Top 10 leading countries in retail e-commerce sales growth in 2021

With advanced (wireless and mobile network) capabilities, the mobile phone had become most significant channel for global businesses to provide personalized communication, promote standard and customized products and services, and engage their target customers anytime anyplace. Initially, the mobile shopping was restricted to

websites in micro-browsers of mobile phones, until introducing smart applications that resulted in accelerating the users' experience. The mobile technology has been proved to be more advantageous to the online shoppers due to its ubiquitous nature, as global consumers can purchase the desired products and services anytime anyplace. The rapid penetration of smartphones, advancement of mobile networks, affordable mobile devices and Internet could be some of the reasons for the quick growth of mobile commerce. As given in figure 3, the retail m-commerce sales worldwide were expected to increase from $967 billion in 2016 to a massive $3,556 billion in 2021 (eMarketer, 2018).
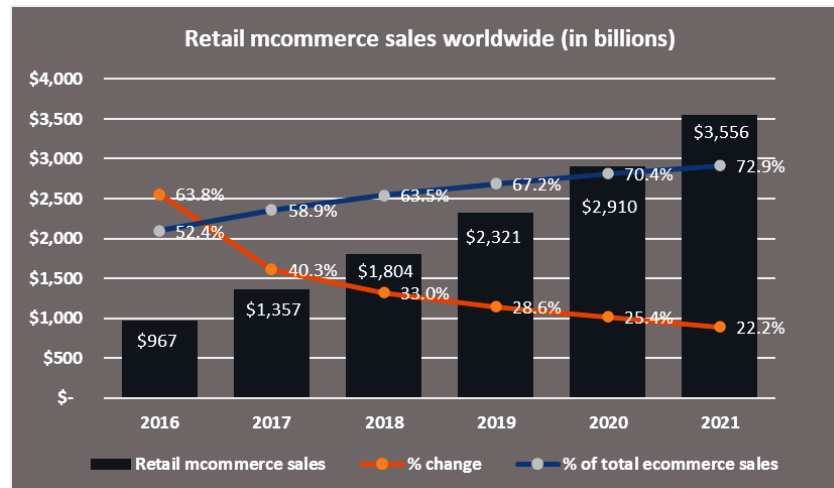

Figure 3: Retail m-commerce sales worldwide from 2016 to 2021 in billions

As noted in figure, the list of fastest growing retail m-commerce countries in the world are dominated by the emerging markets (figure 4), in which India has been ranked the sixth position with 28.3% of growth in 2021 (eMarketer, 2021).
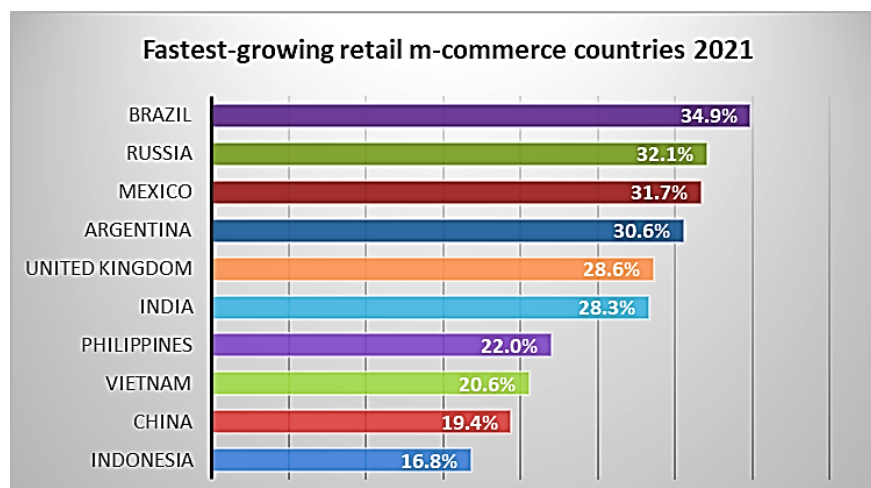

Figure 4: Top 10 fastest growing countries in retail m-commerce in 2021

As the mobile commerce adoption and usage has been rapidly increasing across the world and especially in emerging economies such as in India, it is important for the developers, managers, and marketers of mobile shopping applications, to understand the factors shaping consumers' post buying behavior. The mobile shopping applications have widely been accepted by the consumers in India with the increased penetration of smartphone devices across the market segments. But it is important to focus on the factors that determine the customers' level of loyalty towards a mobile shopping application (service provider). It is necessary for service providers to understand the customers' expectations and perceived beliefs and its outcome, to design their offerings and tap the markets with precise targeting strategies. The primary objective of this study is to identify the determinants of mobile shopping customers' loyalty in India. Further, the study aims at ranking the most significant predictors of customer loyalty in the context of mobile shopping applications.

II. LITERATURE REVIEW AND RESEARCH MODEL

According to Tarasewich et al. (2002), mobile commerce is defined as "all activities related to a (potential) commercial transaction conducted through communication networks that interfere with wireless devices. Hence, mobile commerce (m-commerce) is a comprehensive term which includes mobile banking, mobile ticketing, mobile shopping etc (Akroush et al. 2020).

The literature on mobile shopping has been covering both pre-adoption and post-adoption behavior of customers based on various theories:

- The theory of reasoned action (TRA) (Fishbein and Ajzen 1975),
- the technology acceptance model (TAM) (Davis 1986),
- the theory of planned behaviour (TPB) (Ajzen 1991),
- the diffusion of innovation (DOI) theory (Rogers 1995),
- the unified theory of acceptance and use of technology (UTAUT) (Venkatesh et al. 2003)
- UTAUT2 (Venkatesh et al. 2012)
- the expectation confirmation model (ECM) (Bhattacherjee 2001)

There are many research studies which shown the factors predicting the behavioral intention to do shopping over the mobile websites/applications. Table 1 summarizes the studies related to pre-adoption behavior of mobile shopping literature.

Research studies	Mobile shopping platform	Predictors of pre-adoption behavior
Wu et al. (2004); Aldas-Manzano et al. (2009); Ko et al. (2009); Yang (2010); Hillman et al. (2012); Holmes et al. (2014); Wong et al. (2015); Yang (2016); Gupta and Arora (2017); Chen et al. (2018); Al-Adwan et al. (2019)	Website Application	Quality of merchandise; Assurance; Compatibility; Perceived usefulness, Perceived ease of use; Perceived enjoyment; Perceived value; Social influence; Facilitating conditions; Trust, Convenience; Accessibility; Involvement; Price saving orientation; Variety; Service Quality

Table 1: Select studies on pre-adoption behavior of mobile shopping

Further, the factors that are influencing the post-adoption behaviour of mobile shopping customers had been listed in the table 2:

Research studies	Mobile shopping platform	Predictors of post-adoption behavior
San-Martin & López-Catalán (2013); Al-Dmour et al. (2014); Groß (2015); Kim et al. (2015); Thakur (2018); Lee and Kim (2019)	Website Application	Trust; Involvement; Perceived usefulness; Perceived enjoyment; Attitude; Perceived ease of use; Personalization; Self-efficacy; Simplicity, Mobility, Connectivity; Satisfaction; Hedonic shopping orientation; Consumers' need for mobile app atmospherics; Entertainment gratification

Table 2: Select studies on post-adoption behavior of mobile shopping

A comprehensive research framework has been proposed to identify the determinants of mobile shopping loyalty, as given in figure 5. The model has been configured with six predictor variables (hedonic motivation, price saving orientation, perceived risk, perceived usefulness, perceived trust, and customer satisfaction), which are expected to have significant impact on customer loyalty.

It is important for marketers of mobile shopping applications to keep their customers loyalty for the future growth and to gain competitive advantage in the long term. Loyalty is defined as a "deeply held commitment to rebuy or repatronize a preferred product/service consistently in the future" (Oliver, 1997). The customer loyalty, in this study, characterized as the behavioral outcome of mobile shopping customers to spread positive word-of-mouth and continue purchasing from a specific m-commerce firm.

The hedonic aspects of a technology are found to play a significant role in its adoption and usage (Venkatesh et al. 2012). Hedonic motivation is defined as the extent to which a customer perceives experience of searching and buying over the mobile shopping applications as fun, entertaining, exciting and pleasant. Thus, it is hypothesized that:

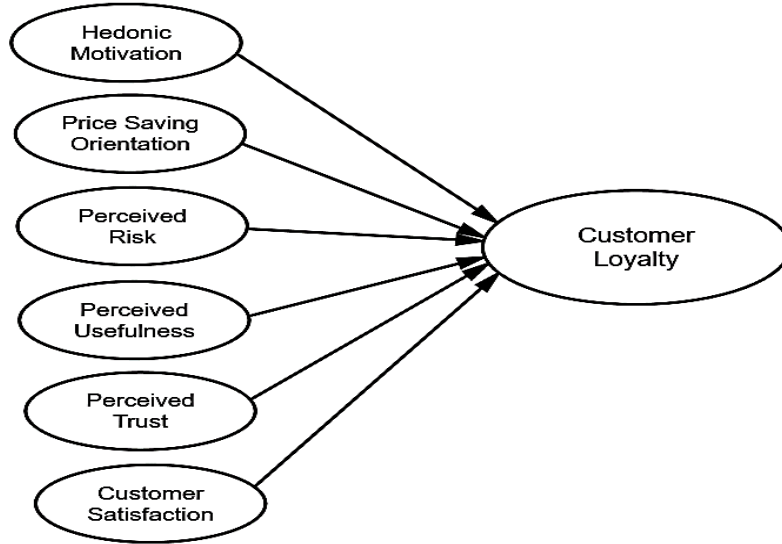H1: Hedonic motivation has a significant influence on customer loyalty.

Figure 5: Research model

One of the major attractions for online shoppers to purchase from mobile shopping applications is savings in time and money. The comparison of prices of products in mobile shopping applications would enable the shoppers to make decisions to buy the right product/brand at right price. Previous research (Escobar-Rodríguez and Carvajal-Trujillo, 2013, Gupta et al. 2018) confirmed the influence of price saving orientation on usage intentions towards the mobile shopping. Hence, it is proposed that:

H2: Price saving orientation has a positive effect on customer loyalty.

Although, the mobile shopping applications are popular among the smartphone users globally, there are still certain concerns about the risks involved in mobile purchases. Perceived risk is defined as "the potential for loss in the pursuit of the desired outcome of using an e-service" (Featherman and Pavlou 2003). When customers perceive the risks are higher in purchasing through mobile applications, their intention to continue buying might be decreasing. Thus, it is hypothesized that:

H3: Perceived risk has a negative impact on customer loyalty.

Mobile shopping applications offer numerous benefits to its customers in terms of ubiquity, convenience, time savings, price savings etc. and are considered to be a better alternative of shopping in today's digital world. Perceived usefulness is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989). The positive influence of perceived usefulness on continuance intention to use a technology has been confirmed in the literature (Bhattacherjee, 2001). Hence, it is proposed that:

H4: Perceived usefulness has a positive influence on customer loyalty.

The credibility of a m-commerce firm, in fulfilling promises, plays a key role in customers' decision to continue purchasing from a mobile shopping store. Perceived trust is defined as "a psychological state comprising the intention to accept vulnerability based on positive expectations of the intentions or behaviours of another" (Rousseau et al. 1998). It is assumed that when mobile shoppers perceive mobile shopping application to be reliable, they are more likely to continue using it. Therefore, it is postulated that:

H5: Perceived trust has a significant influence on customer loyalty.

The ECM posited that the users' intention to continue using a technology is primarily driven by their satisfaction with previous use. Satisfaction is defined as "the psychological or emotional state resulting from a cognitive assessment of the gap between the expectations and the actual performance of an information system" (Oliver, 1981). In both marketing and information system literature, the heightened importance of satisfaction has been widely recognized in shaping the future usage behavior of a product or service. Hence, it is proposed that:

H6: Customer satisfaction has a significant impact on customer loyalty.

III. METHODOLOGY

The primary data for this study was collected through an online survey using convenience sampling technique. The questionnaire was designed by including (i) the measurement scales of study's constructs and (ii) the demographic profile of the respondents. The scale items of all constructs were derived from the previous literature on mobile shopping literature. After the data collection for a period of 12 weeks, 535 valid responses were used for validating the proposed research framework of the study.

The demographic profile of the respondents is summarised as follows:

- The maximum number of respondents were male i.e., 341 (63.7%) and a total of 194 (36.3%) female respondents participated in the survey.
- Most of the respondents 234 (43.7%) belonged to the age group of 25-34 years, 143 (26.7%) of respondents were in the age group of 35-44 years, 117 (21.9%) of respondents were in the age group of 18-24 years and only 41 (7.5%) were in the age group of 45 and above years.
- About the education of the respondents, 40.2 % (n=215) were having bachelor's degree, 35.3% (n = 189) were possessing master's degree, and the remaining 24.5% (n = 24.5%) were having professional and other degrees.

A multivariate statistical technique, exploratory factor analysis (EFA) was applied in order to identify the underlying factorial structure of measured variables and to examine its internal reliability. This further helps in comprehending the nature and number of factors that explain the total variance of the data. Next, the internal consistency reliability of the factors derived from EFA, was done by Cronbach's alpha. Further, the multiple regression analysis (MRA) was used to test the influence of independent variables on dependent variable, as hypothesized in the proposed research model. Finally, the artificial neural networks (ANNs), a black box approach, was used to measure the linear, non-linear, and non-compensatory relationships between predictors and dependent variable. The IBM SPSS software was used for the purpose of performing various statistical analysis in this study.

IV. RESULTS

The Kaiser-Meyer-Olkin (KMO) measure is used as an index of whether there are linear relationships between the variables and thus whether it is appropriate to run factor analysis on study's data set. As given in table 3, the KMO test value is above 0.9, which demonstrates the appropriateness of the data. Bartlett's test of sphericity signifies whether a correlation matrix is an identity matrix, that would imply that variables are unrelated. The significance level of 0.000 (table) confirmed that there were significant relationships among the variables.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.903
Bartlett's Test of Sphericity	Approx. Chi-Square	13320.462
	Df	253
	Sig.	0.000

Table 3: KMO and Bartlett's Test

After validating the adequacy and significance of the study's data, the factor analysis was performed by using principal component analysis as an extraction method and varimax as a rotation method. The communality is the proportion of each variable's variance that is accounted for by the principal components analysis and can also be expressed as a percentage. The items with low communality should be removed from further analysis. As evident in table 4, the values of all items are higher than 0.4, hence no items are eliminated from the analysis.

Items	Initial	Extraction	Items	Initial	Extraction
HM1	1.000	0.942	PT1	1.000	0.897
HM2	1.000	0.939	PT22	1.000	0.902
HM3	1.000	0.941	PT33	1.000	0.945
PSO1	1.000	0.908	SAT1	1.000	0.847
PSO2	1.000	0.920	SAT2	1.000	0.880
PSO3	1.000	0.947	SAT3	1.000	0.784
PR1	1.000	0.920	SAT4	1.000	0.815
PR2	1.000	0.786	LOY1	1.000	0.723
PR3	1.000	0.844	LOY2	1.000	0.808
PU1	1.000	0.899	LOY3	1.000	0.867
PU2	1.000	0.929	LOY4	1.000	0.729
PU3	1.000	0.898			
Extraction Method: Principal Component Analysis.					

Table 4: Communalities

The result of factor analysis (table 5) revealed seven factors with eigen values of above one are extracted, which together explained a variance of 87.26%. The rotated component matrix, as shown in table, for PCA with varimax rotation confirmed the loadings of items in extracted five factor structure.

	SAT	LOY	HM	TR	PSO	PR	PU
SAT1	**0.822**	0.164	0.101	0.208	0.219	0.121	0.171
SAT2	**0.781**	0.297	0.122	0.224	0.251	0.149	0.178
SAT3	**0.793**	0.185	0.086	0.199	0.183	0.106	0.170
SAT4	**0.753**	0.301	0.095	0.209	0.177	0.197	0.184
LOY1	0.181	**0.744**	0.059	0.198	0.157	0.166	0.205
LOY2	0.212	**0.784**	0.148	0.174	0.214	0.166	0.151
LOY3	0.188	**0.821**	0.096	0.126	0.216	0.224	0.189
LOY4	0.272	**0.747**	0.128	0.120	0.135	0.188	0.111
HM1	0.103	0.079	**0.920**	0.105	0.090	0.140	0.202
HM2	0.075	0.093	**0.915**	0.119	0.104	0.135	0.210
HM3	0.120	0.166	**0.906**	0.120	0.130	0.149	0.155
PT1	0.264	0.141	0.130	**0.864**	0.129	0.098	0.133
PT2	0.179	0.149	0.115	**0.883**	0.153	0.143	0.109
PT3	0.235	0.242	0.123	**0.874**	0.146	0.133	0.114
PSO1	0.249	0.195	0.155	0.175	**0.836**	0.172	0.156
PSO2	0.252	0.245	0.112	0.145	**0.840**	0.159	0.178
PSO3	0.231	0.232	0.112	0.150	**0.871**	0.136	0.170
PR1	-0.154	-0.242	-0.159	-0.131	-0.100	**-0.873**	-0.153
PR2	-0.102	-0.165	-0.115	-0.091	-0.190	**-0.822**	-0.120
PR3	-0.172	-0.203	-0.163	-0.138	-0.111	**-0.840**	-0.100
PU1	0.247	0.221	0.247	0.129	0.167	0.123	**0.818**
PU2	0.239	0.232	0.273	0.120	0.161	0.148	**0.825**
PU3	0.154	0.172	0.185	0.143	0.180	0.157	**0.856**
Eigenvalues	10.954	2.289	1.725	1.573	1.295	1.152	1.082

Explained variance (%)	47.624	9.952	7.498	6.841	5.631	5.009	4.705
Total explained variance (%)	47.624	57.576	65.074	71.916	77.546	82.556	87.260

Table 5: Exploratory factor analysis

The Pearson correlation matrix (table 6) shows the linear relationships among the factors, and to ensure the absence of multicollinearity (correlation values of above 0.70). The results given in table are found to be significant, confirming the existence of correlation between factors. Further, the values of correlation between factors were below 0.7, indicating the non-existence of multicollinearity issues.

Variables	HM	PSO	PR	PU	PT	SAT	LOY
HM	1						
PSO	.350**	1					
PR	-.381**	-.434**	1				
PU	.510**	.498**	-.421**	1			
PT	.334**	.444**	-.375**	.406**	1		
SAT	.336**	.591**	-.440**	.542**	.556**	1	
LOY	.351**	.559**	-.523**	.533**	.477**	.604**	1

Table 6: Pearson's correlation matrix

Finally, the internal consistency reliability of all factors was checked by computing the Cronbach's alpha values. A factor is said to be highly reliable when the value of Cronbach's alpha is above 0.7. As given in table 7, all constructs had a high level of internal consistency, as determined by Cronbach's alpha values of above 0.9.

Construct	No. of Items	Cronbach's alpha
Hedonic Motivation	3	0.965
Price Saving Orientation	3	0.959
Perceived Risk	3	0.904
Perceived Usefulness	3	0.948
Perceived Trust	3	0.950
Customer Satisfaction	4	0.926
Customer Loyalty	4	0.903

Table 7: Reliability analysis

The hypothesis proposed in this study were tested through multiple regression analysis, which predicts a dependent variable based on multiple independent variables. This technique allows us to determine the overall fit (variance explained) of the model and the corresponding contribution of each of the predictors to the total variance explained. As given in table 8, the value of r square, demonstrating the predictive power of the model, is 50.9% said to be satisfactory. The predictor variables combined are explaining around 51% of the variance in customer loyalty. The measure of Durbin-Watson test was performed to check the absence of autocorrelation among the factors. It is recommended that this test statistic value should be close to 2, indicating the non-existence of autocorrelation. As given in table, the test statistic confirmed that there was no autocorrelation among the factors.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.714ᵃ	0.509	0.504	1.97388	1.926
Predictors: (Constant), SAT, HM, PR, PT, PSO, PU					
Dependent Variable: LOY					

Table 8: Model Summary

The ANOVA test results showed the significance of the model (Table 9). Hedonic motivation, price saving orientation, perceived risk, perceived usefulness, perceived trust and satisfaction statistically significantly predicted customer loyalty, $F(6, 528) = 91.367$, $p < 0.001$.

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	2135.896	6	355.983	91.367	.000b
	Residual	2057.188	528	3.896		
	Total	4193.084	534			
Dependent Variable: LOY						
Predictors: (Constant), SAT, HM, PR, PT, PSO, PU						

Table 9: ANOVA results

The multicollinearity of the statistics was verified with the help of two measures viz. variance inflation factor (VIF) and tolerance values. Table 10 confirmed that there was no problem of multicollinearity as the VIF values are less than 10 and tolerance values are less than 2.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	8.345	0.830		10.057	0.000		
	HM	-0.006	0.038	-0.005	-0.146	0.884	0.694	1.441
	PSO	0.238	0.051	0.186	4.625	0.000	0.575	1.740
	PR	-0.287	0.047	-0.223	-6.134	0.000	0.700	1.428
	PU	0.175	0.041	0.174	4.234	0.000	0.553	1.807
	PT	0.129	0.046	0.106	2.795	0.005	0.645	1.550
	SAT	0.257	0.046	0.244	5.605	0.000	0.489	2.045
Dependent Variable: LOY								

Table 10: Results of Multiple Regression Analysis

The result of multiple regression analysis to validate the hypothesis of this study is given in table 10. Five out of six independent variables were found to have significant influence on customer loyalty, except hedonic motivation. Price saving orientation, perceived risk, perceived usefulness, perceived trust, and satisfaction statistically significantly to the prediction, $p<0.05$. Hence H2 to H6 are strongly supported and H1 is not supported as the relationship between hedonic motivation and customer loyalty is insignificant.

Hidden layer activation function: Sigmoid
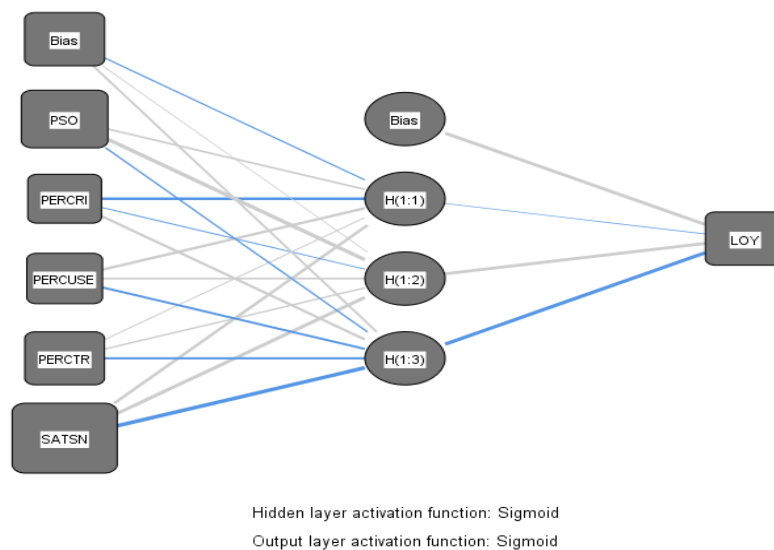Output layer activation function: Sigmoid

Figure 6: ANN model

Artificial Neural Networks (ANNs) are one of the most commonly used artificial intelligence methods, which is considered to be more sophisticated, robust and highly efficient in modelling complex relationships among inputs

and outputs. Artificial neural network (ANN) is defined as ''a massively parallel distributed processor made up of simple processing units, which have a neural propensity for storing experimental knowledge and making it available for use'' (Haykin 2010). ANN is analogical to the human brain in the sense that knowledge is obtained by the network via learning procedure while the synaptic weights (i.e. inter-neuron connection strengths) is utilized to keep the knowledge for future use. ANN has been found to have higher prediction accuracy while comparing with other traditional linear techniques such as Multiple Regression Analysis, Structural Equation Modeling and Multiple Discriminant Analysis. The ANN analysis was performed using IBM's SPPS neural network module. This algorithm can capture both linear and nonlinear relationships and does not require any distribution of data. "This algorithm can learn from the training process to estimate the outcome of the analysis using feed-forward-back-propagation (FFBP) algorithm, in which inputs are feed in a forward path and estimated errors will move in a backward direction" (Taneja and Arora 2019).

Training			Testing		
N	SSE	RMSE	N	SSE	RMSE
475	3.543	0.086	60	0.493	0.091
469	3.887	0.091	66	0.485	0.086
477	3.892	0.090	58	0.347	0.077
479	3.731	0.088	56	0.540	0.098
476	3.875	0.090	59	0.547	0.096
484	4.002	0.091	51	0.321	0.079
474	3.654	0.088	61	0.504	0.091
481	3.807	0.089	54	0.395	0.086
485	4.148	0.092	50	0.397	0.089
471	3.554	0.087	64	0.584	0.096
Mean	3.809	0.089	Mean	0.461	0.088
Standard deviation	0.183	0.002	Standard deviation	0.086	0.007

Table 11: RMSE Values

The study used multilayer perceptrons and sigmoid activation functions for the input and hidden layers (figure 6). The errors could be minimised, and prediction accuracy can be improved further through many rounds of the learning process. As per the requirement of procedure, 90% of the samples were allocated for the training process and the remaining 10% was utilized for the testing procedure. The ten-fold cross-validation procedure was done to elude the problem of overfitting, and the root mean square of errors (RMSE) values were obtained. Table 11 illustrates that the mean RMSE values of the training and testing procedures are quite small at 0.089 and 0.088, respectively. Hence, it is confirmed that there is an exceptional model fit.

PSO	PR	PU	PT	SAT
0.116	0.286	0.164	0.127	0.308
0.216	0.177	0.177	0.090	0.341
0.266	0.216	0.134	0.063	0.321
0.245	0.229	0.147	0.125	0.255
0.222	0.273	0.116	0.116	0.273
0.162	0.215	0.139	0.202	0.282
0.228	0.222	0.158	0.129	0.264
0.231	0.245	0.170	0.073	0.281
0.191	0.131	0.105	0.239	0.333
0.169	0.226	0.169	0.122	0.313
0.205	0.222	0.148	0.129	0.297
69%	*75%*	*50%*	*43%*	*100%*

Table 12: Sensitivity analysis

Next, the normalized importance of each predictor has been calculated using sensitivity analysis (table 12). In the order of importance towards LOY in descending order is SAT, PR, PSO, PU and PT. The graphical representation of sensitivity analysis has been illustrated in figure 7, which highlights the relative importance of various constructs used to predict the customer loyalty. It was observed that satisfaction is the most significant factor, followed by perceived risk, price saving orientation, perceived usefulness, and perceived trust.
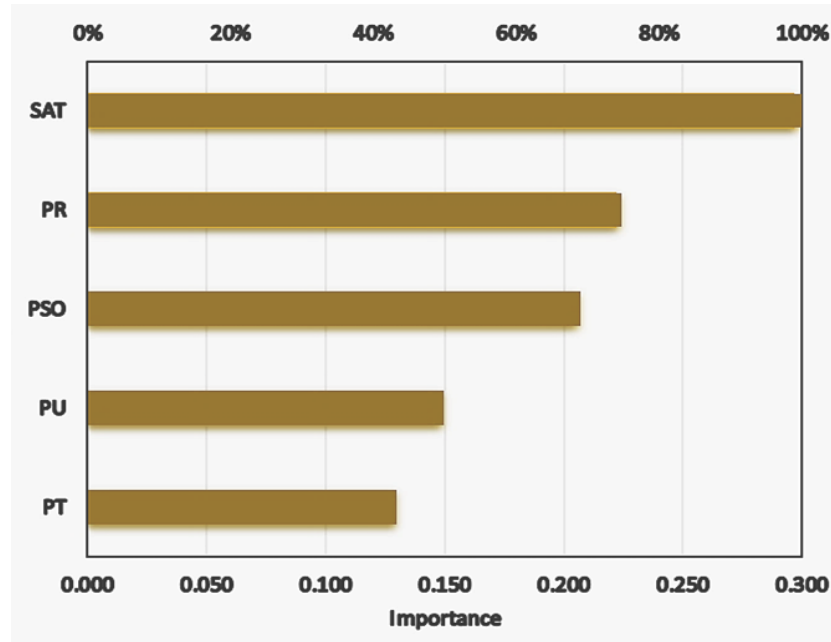

Figure 7: Relative importance of predictors

V. DISCUSSION, IMPLICATIONS AND LIMITATIONS

Customer loyalty has been considered to be the most significant factor in determining the profitability, growth and sustainable competitive advantage of a business firm. It is important for marketers to focus on the factors that are shaping the customers' loyalty and design their strategies for their long-term success in any competitive marketplace. Therefore, the customer loyalty has been recognized as a key focus of businesses in the current volatile market environment. This research has identified the key determinants of customer loyalty and the relative importance of these factors, enabling m-commerce firms to have deeper understanding of the customers repurchase behavior. Most of the previous studies in the context of mobile shopping have focused on behavioral intentions to purchase products or services from the mobile shopping platform, whereas the uniqueness of this study is highlighting the antecedents of customer loyalty and their significance in shaping the post-purchase behavior.

The results of multiple regression analysis have revealed that perceived risk, satisfaction, price saving orientation, perceived usefulness and perceived trust are significantly influencing the customer loyalty, whereas the impact of hedonic motivation was insignificant. These results were further cross verified by applying the ANN technique. The satisfaction was identified to be most important factor that influences the customer loyalty towards the mobile shopping applications. As noted popularly in the literature, the level of satisfaction of mobile shopping customers would positively enhance their word-of-mouth behavior and repurchase intentions towards the mobile shopping platforms. Next, perceived risk was found to be the second most significant factor in influencing the customer loyalty i.e., the risk perceptions of mobile shopping customers would have negative impact on their preference to continue buying from a specific m-commerce application. Hence, the marketers need to ensure that the mobile shopping applications are secured in all aspects of customer expectations and deliver the services as promised, minimizing the risk perceptions of shoppers.

One of the significant contributions of this study is uncovering the positive impact of price saving orientation on customer loyalty. It can be concluded that customer loyalty can be improved when they perceive shopping through mobile shopping applications would result in greater savings of money. Today, the discounts and other promotional offers play a key role in attracting and retaining customers with a particular mobile shopping

application. Next, perceived usefulness, noted as one of the key determinants of adoption and usage of a technology in the literature, found to significantly influence the customer loyalty. Finally, perceived trust, is identified as the least important factor according to ANN technique, still has a positive effect on customer loyalty. The mobile shopping customers repurchase intentions would be enhanced based on their perceptions about the reliability of services offered by the m-commerce firms.

The uniqueness of this study lies in identifying the linear and non-linear relationships between predictors and customer loyalty, through multiple regression analysis and ANN. Another significant contribution is highlighting the relative importance of determinants of customer loyalty through ANN technique. The limitations of the study are in terms of responses collected from mobile shopping customers in a single point of time (cross-sectional research design), through online survey using nonprobability sampling method. Hence, it is recommended that the future research should be conducted by comparing the behavioural differences of mobile shopping customers based on regions (urban vs. rural), demographics and other technological characteristics, through the proposed research framework. Finally, the future research can identify the changes in preferences, by focusing on longitudinal research design.

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