Empirical Examination of the Role of Three Sets of Innovation Attributes for Determining Adoption of IRCTC Mobile Ticketing Service

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Abstract

IRCTC's mobile ticketing was recently introduced in India. In studying its adoption, three competing attribute-sets are compared. This study aims to reveal the attribute-set best predicting its adoption. The research model was empirically tested and validated using SPSS. Four attributes from the DOI theory, four from the PCI theory, and four from Tornatzky and Klein's meta-analysis significantly affected behavioral intentions. Only complexity failed to influence use intentions, and behavioral intention and riskiness significantly impacted adoption.

Keywords: *Adoption, DOI, IRCTC, Mobile ticketing, PCI.*

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1. Introduction

Owing to advantages of providing access to the remote interiors of Indian towns and villages, and at the same time being very reasonably priced in terms of ticket costs, the Indian railways have grown out to be a very popular and preferred means of transport among the Indian citizens (Patel & Grover, 2010). The modern day technology provides an added enhancement to this transport system by introducing a mobile application that allows making railway bookings using mobile phones. This mobile ticketing application is a secure mobile ticketing solution that was very recently launched by the *Indian Railway Catering and Tourism Corporation Limited (IRCTC).* This application introduces an element of convenience for the railway commuters by making possible the booking of railway tickets on the go, using mobile phones. The use of this ticketing application requires the users to register themselves with IRCTC using their mobile phone numbers. This is then to be followed by the download and installation of the mobile application on Java enabled (GPRS – General Packet Radio Service activated) mobile phones.

This ticketing application, still being in its initial changes has been undergoing continuous changes and upgrades since our study commenced. Essentially, these changes were brought in place to make this application compatible with even the CDMA (Code Division Multiple Access) phones. The official webpage of this application shows that numerous mobile companies have stepped up to partner with IRCTC as the functional providers of this application. The webpage also reveals that even banks such as ICICI are partnering with them as the active providers of this service (IRCTC, 2013). However, as of June 2012, which was when our study began, Paymate, ngpay and Atom (IRCTC, 2012) were the only three providers of this application. Even after substantial research, it has not been very clear as to how many and which of these service providers currently exist. Giving consideration to the fact that the newness of this application makes it susceptible to constant changes and upgrades, our study chose to acknowledge only the three service providers that were in use during the time at which our survey began, which is potentially why our questionnaires only comprise of only these three aforementioned service providers.

The mobile ticketing way of booking railway tickets is very similar to e-ticketing way of booking the tickets using the internet. The only difference being, the consumers can now book tickets on the move, ubiquitously on their mobile phones. IRCTC claim that the payment system associated to the mobile ticketing is totally secure. Both, the transmitted and stored data on the mobile phones are fully encrypted. They also claim that the privacy, authentication, and security requirements are fulfilled by this application. In explaining the cost associations, they reveal that there are no additional costs levied on the commuters in booking railway tickets using this application. However, since the mobile application acquires data connections from the 3G/4G mobile network providers to access the internet, these service providers may levy different data charges on their customers depending upon their data/internet plans (IRCTC, 2013). The highlight feature of being able to use different services on mobile phones is the ability of accessing these services from practically anywhere, ubiquitously (Liang, Huang, Yeh, & Lin, 2007). The same association can be made to the use of this mobile ticketing application, in that it offers the commuters a facility of making railway bookings at any time of the day and week, which in effect turns out to be not only time effective, but also cost effective.

A specific literature search on this topic brought to light the fact that although many studies on the adoption of mobile commerce (Barnes, 2002; Siau & Shen, 2003) and mobile payment (Wu & Wang, 2005; Dahlberg, Mallat, Ondrus, & Zmijewska (2008) are present, there are no publications present on the adoption of the IRCTC mobile ticketing application. A more narrowed search for literature on the IRCTC mobile ticketing application fetched very few studies that only either very briefly discussed the ticketing application or merely mentioned its existence in the mobile commerce context, which have been listed and briefly detailed in the literature review section of this paper. Being in its initial stages, and still slowly diffusing in the Indian context, can be seen as

the potential reasons behind the absence of studies on the adoption of this technology in the existing literature. On a broader level, there are no official reports or government statistics existing which can account for the factors that affect the adoption of this technology in India. Therefore, it was considered essential and important to undertake an empirical examination of both, the facilitating and receding adoption factors for the IRCTC mobile ticketing application in the Indian context. The aim of this study therefore was to empirically investigate and examine the roles of the different sets of innovation attributes in influencing the acceptance of this mobile ticketing application by the Indian railway commuters. The findings from our study could help reveal an authentic set of results that could assist in extending useful information to the stakeholders of this application on the favourable adoption factors of this technology, which they could use to formulate competitive strategies for a wider promotion of this technology, which in effect could help accelerate its adoption rate, in return.

Having introduced the mobile ticketing application, the following part of this paper reviews the literature on the mobile commerce and mobile ticketing applications adoption. The section following next will brief the readers with the theoretical basis of this study, and also propose related hypotheses with reference to the model proposed for this study. The focus will then shift on elaborating on the research method undertaken by this study, by detailing on the survey instrument, pilot study and the data collection process. This will be succeeded by an illustration of the findings and the SPSS test results that were arrived at, upon subjecting the gathered data to various tests using the SPSS analysis tool. A discussion section is then introduced, wherein the statistics from the SPSS tests are interpreted against the proposed hypotheses for testing the validity of the proposed model for this study. Laid next will be the conclusions, where the key outcomes are highlighted. The shortcomings from this study are then identified under limitations, and suggestions for future research are finally made.

2. Literature Review

IRCTC offers its registered commuters a privilege of booking railway tickets using the 3G/4G mobile data from their phone network providers to access the internet on the run for making the railway bookings and confirming the payment for the tickets over a simple mobile phone application. This application is therefore a clear integration of mobile payment and mobile ticketing services. The literature is rich with publications on mobile commerce. Some of these publications have been briefly detailed here – Mallat (2007) studied mobile payments adoption using focus groups which revealed that relative advantage and compatibility behaved as the significant influencers of adoption; Chen (2008) also studying mobile payments adoption used the technology acceptance model and the innovation diffusion theory which helped conclude that perceived ease of use, perceived risk, and compatibility significantly impacted the adoption decisions; Schierz, Schilke, & Wirtz (2010) again studying adoption of mobile payment services concluded that compatibility, subjective norm and individual mobility were the important predictors of its adoption; another recent study on the adoption of mobile commerce in the Indian context showed in their results that self efficacy, perceived enjoyment and perceived usefulness behaved as the significant predictors of adoption (Dwivedi, Tamilmani, Williams, & Lal, forthcoming IJICBM); Koenig-Lewis, Palmer & Moll (2010) studied mobile banking services adoption in a German context and found that perceived usefulness, compatibility and risk behaved as the significant determinants of adoption.

As mentioned earlier in the introduction section, our search for studies on the mobile ticketing adoption did not yield many results. Some of these studies have been discussed here – a study on mobile ticketing for public transportation used attributes, both from the technology acceptance model and Rogers' diffusion of innovations theory and found compatibility making the strongest impact on adoption intention, and perceived usefulness and ease of use also making a strong impact on the adoption of the ticketing application (Mallat, Rossi, Tuunainen, & Oorni, 2008); Mallat et al.

in another study on the mobile ticketing services adoption in 2009 found in their results that ease of use and compatibility played the important predictors of adoption intention, and relative advantage showcased a non significant effect on adoption intention. As also highlighted in the introduction of this paper, not many studies specific to the IRCTC mobile ticketing application were found either. The few studies briefly discussing or mentioning this ticketing application have been summarized here - a study on Indian railways for the modernization of the passenger reservation system vaguely mentions the possibility of these reservation services to be soon made available on mobile phones by IRCTC (Srivastava, Mathur & Teo, 2007). Singh & Yammiyar (2008), in evaluating the Indian market for mobile commerce developed a user-centred approach and they also chose to only mention mobile ticketing and continued with proposing a design for macro commerce application that would serve well for the information needs of the commuters across the nation. Patel & Grover (2010) although do a study directly related to the IRCTC mobile ticketing application, they focus on developing a map based source and destination input mechanism for the application, with no attention being paid to the adoption of this mobile ticketing application, whatsoever. Our search also fetched a master thesis on the biometric authentication on mobile payments, whereby the concept of the IRCTC mobile application and its use have been briefly introduced (Sreekumar, 2010).

These above mentioned publications are evidences to confirm that despite the presence of numerous studies on mobile commerce and mobile payment adoption, notably, very few studies on the mobile ticketing services adoption have been undertaken. Most particularly, not a single study attempts to identify the adoption factors and the extent of adoption of the IRCTC mobile ticketing application in the Indian context. Placing repeated emphasis on the fact that this ticketing application is a recent introduction in the Indian markets which is still in its initial diffusion stages, the non-existence of literary investigations in the context of this application thus becomes explainable. The preceding explanation reiterates the importance and the motivation behind our study. This study, therefore, takes the initiative to examine the factors that may or may not influence the adoption of this application to bring to light the behavior of the shortlisted innovation attributes on the adoption intention and adoption of this mobile ticketing application in the Indian context.

Bringing to light, the effect of these influential attributes, may serve in providing the stakeholders with a directive view for formulating competitive strategies that may further assist in encouraging a wider adoption of the mobile ticketing application in the Indian context. Also, given that most of the technologies in today's world are being made available on a mobile platform as applications on a mobile phone that can be conveniently used from anywhere at any time, the results from this study will serve as a literary contribution in terms of presenting the behavior of the chosen set of attributes in reference to the adoption of mobile applications in general, and mobile ticketing applications, in particular.

3. Theoretical Basis and Hypotheses Development

According to Rogers (2003), the commonest issue revolving the diffusion of an innovation under consideration, is the need to accelerate its diffusion rate; in doing so, what is required out of the managers and implementers of these innovations? In discussing and evaluating the adoption rate of the IRCTC mobile ticketing application in India, some of the questions that quickly surface are – what factors steer the adoption rate of this application? Does the user background or societal influences have an effect on the adoption decisions of the commuters? How aware are the potential users of this application of its existence and benefits, and to what extent does the technology awareness affect its adoption rate? In fetching constructive answers to all of the aforementioned questions, the stakeholders potentially require clarity and statistically apt information on the important factors that promote increased usage of this mobile ticketing application.

Equal importance needs to be given to the fact that the mobile ticketing way of booking railway tickets is only another option, in addition to the pre-existing and well established systems of over-the-counter physical booking of railway tickets at IRCTC offices, and the internet way of booking tickets. In delving into its adoption factors the most evident question on the forefront is that why would the commuters choose mobile ticketing over the pre-existing systems with which they are already comfortable. To address all these issues collectively, a suitable model had to be chosen that would help examine what factors most influenced consumers' use intention, and in turn the actual adoption of this mobile ticketing application.

The field of *innovation diffusion and adoption* has many models to its account that help predict the adoption intention and the actual adoption of different innovations, some of most frequently used of which have been listed here - The Theory of Planned Behavior (TBP), Technology Acceptance Model (TAM), Unified Theory of Acceptance and Use of Technology (UTAUT), Theory of Reasoned Action (TRA) are some such examples. Interestingly, these above listed models have been using similar kind of attributes in predicting the adoption and diffusion patterns of innovations. The Diffusion of Innovations (DOI) theory introduced by Rogers in 1962, on the other hand, in comparison, is a much more established and even more frequently used model with a distinct set of attributes. Rogers (2003) in his DOI theory identified *relative advantage, compatibility, complexity, trialability, and observability* as the five innovation-attributes that effectively explained the adoption of an innovation under consideration. Being a popular theory amongst the innovation adoption studies, the attributes from the DOI theory have been adopted by many studies over time to investigate the adoption of many different technological innovations. Some such studies are –environmental innovations (Sia, Teo, Tan, & Wei, 2004), innovations in health service industry (Greenhalgh, Robert, Macfarlane, Bate, & Kyriakidou, 2004) and clinical practice (Legare, Ratte, Gravel, & Graham, 2008), wiki technology (Hester & Scott, 2008), innovations in mobile ticketing (Mallat et al., 2008), mobile data services (Grepott, 2011), innovation adoption research (Kapoor, Dwivedi, Williams, & Lal, 2011; Kapoor, Dwivedi, & Williams, 2014) and many others. These studies have been listed here to stress that Rogers' DOI theory is well established in the field of innovations, and its innovation-attributes have vast usage in the adoption-diffusion research. These five Rogers' attributes were thus concluded to be both, appropriate and important from our study's perspective. It was therefore decided to use them as the primary attribute-set to be examined under this study.

A note worth making at this stage is that although Rogers' DOI theory is well established and preferred by most studies, there are other innovation attributes apart from these five attributes that have received considerable attention and have been extensively utilized to study the influencers of innovation adoption. After Rogers', the next significant literary contribution to the field of innovations was made through the meta-analysis of innovation attributes by Tornatzky & Klein (1982). They listed 30 innovation attributes in total, five of which were Rogers' innovation attributes. The 25 other innovation-attributes were being extensively used by the then recent studies to examine IT innovations. These 25 attributes were also thus concluded to be of relevance and importance to this study, and included to be examined under this study.

Another remarkable contribution in the field of innovations was that made by Moore & Benbasat (1991) through their *Perceived Characteristics of Innovating* (PCI) theory. They used a set of eight attributes, three of which were borrowed from Rogers' DOI theory. Their work was a significant contribution, whereby they proposed and developed an instrument capable of measuring the individual perceptions associated to the adoption of an IT innovation. The other five attributes in their attribute-set were *voluntariness*, *image*, *ease of use*, *result demonstrability*, and *visibility*. Since the Rogers' attribute-set used *complexity* and Moore and Benbasat's attribute-set used *ease of use*, which in effect is an absolute opposite of complexity, these two attributes were regarded as the measures of the same type of innovation factor, only being measured in the opposite directions. In the interest of avoiding overlap and duplication of the adoption factors, it was decided that the ease

of use would be deleted and only the remaining four innovation attributes - *voluntariness*, *image*, *result demonstrability*, and *visibility* will be used for this study. Interestingly, another attribute, *image*, also made its presence across two attribute-sets, which were Moore and Benbasat's attribute-set and Tornatzky and Klein's attribute-set. Again, to overcome overlap, image was chosen to be dismissed from the Tornatzky and Klein's list of attributes.

In total, 32 attributes (five from Rogers' *Diffusion of Innovations* theory, 23 from Tornatzky & Klein's *meta-analysis*, and four from Moore & Benbasat's *Perceived Characteristics of Innovating* theory) had now been shortlisted to be examined for their impacts on the adoption of the IRCTC mobile ticketing application in the Indian context. To confirm both, the usage, and the practical implications of these shortlisted attributes, we undertook a screening process, wherein, it was decided that the usability of these 32 innovation attributes will be identified in the recent publications. In doing this, a criterion was set, according to which all publications citing Rogers' DOI theory would be searched for, in the literature. A timeline was also set, whereby all publication from 1996 onwards would be retrieved. Although, Rogers last book (5th edition) was released in 2003, numerous studies continued to cite the fourth edition of his book (1996), and hence the set timeline. In the search for all 32 innovation attributes, it was found that only 16 of these made their presence in the publications extracted from the literature. Since three out of these 16 innovation attributes were put in use by only one publication, they were discarded from the attribute-sets for our study. This left only 13 attributes that effectively were being extensively utilized by the recent studies. Typically, 19 out of the total 23 attributes from Tornatzky& Klein (1982) had not been in recent use and hence discarded from this study, leaving only four innovation attributes of use – *cost*, *communicability*, *riskiness*, and *social approval*.

All of the three attribute-sets have been exclusively explained, alongside the proposed hypotheses relevant to the individual attributes, in the paragraphs that follow.

Attribute-set I

Relative Advantage

According to Rogers (2003), relative advantage is the measure of degree to which an innovation is perceived to be better than the idea that it is superseding. Having extensive usage, this attribute has been popular amongst varied innovative technologies, wherein it was observed having a significant influence on the adoption intentions of different innovations, for instance – electronic data interchange (Premkumar, Ramamurthy, & Nilakanta, 1994), distributed work arrangements (Sia et al., 2004), mobile internet (Hsu, Lu, & Hsu, 2007), online portal (Shih, 2008), electronic shopping (Ha & Stoel., 2009), and mobile banking services (Koenig-Lewis et al., 2010). Here the mobile application supersedes the ideas of over-the-counter type and the electronic type of railway bookings, and therefore this attribute was considered appropriate in the IRCTC mobile ticketing context and posited as shown below,

H1: *Relative Advantage will make a significant impact on the behavioral intentions of the IRCTC commuters.*

Compatibility

According to Rogers (2003), compatibility is the measure of the degree to which an innovation is perceived to be consistent with the existing values, past experiences, and the current needs of potential adopters. This attribute was found exerting a positive and significant influence over the use intentions across different innovations, such as, e-government services (Carter & Belanger, 2005), mobile network (Hsu et al., 2007), mobile ticketing (Mallat et al., 2008), mobile payment services (Chen, 2008; Schierz et al., 2010), and mobile virtual network (Shin, 2010). Booking tickets on a mobile application is similar to booking tickets online, but is different from the counter

bookings. Being compatible in terms of serving the needs of commuters, in helping them avail their tickets while on-the-move, it was thought of to be interesting to study how commuters associated compatibility with the IRCTC mobile ticketing. The hypothesis, thus formulated is,

H2: *Compatibility will make a positive impact on the behavioral intentions of the IRCTC commuters.*

Complexity

According to Rogers (2003), complexity is the measure of the degree to which an innovation is perceived to be relatively difficult to understand and use. This attribute is often seen extending a direct significant negative influence on the users' adoption intentions and use decisions, some example studies of which are – service innovation adoption study by Frambach, Barkema, Nooteboom, & Wedel (1998), a study on structural equation modelling by Brumec (2006), automatic cash payment systems adoption study by Yang, Lai, & Tsai (2006), and a mobile marketing adoption study by Tanakinjal, Deans, & Gray (2010). The level of ease or complexity involved in operating the IRCTC ticketing application on mobile is bound to be perceived differently by different users. This attribute has therefore been posited as,

H3: *Lower complexity will make a positive impact on the behavioral intentions of the IRCTC commuters.*

Trialability

According to Rogers (2003), trialability is the measure of the degree to which an innovation is available to be experimented on a limited basis. Trialability has been seen extending a fairly significant effect on the users' adoption intentions across different innovations. Some examples of such behavior are – mobile internet study by Hsu et al. (2007), e-MBA adoption study by Mahmod, Dahlan, Ramayah, Karia, & Asaari (2005), consumer innovation adoption study by Arts et al. (2011), e-learning systems acceptance study by Lee, Hseih, & Hsu (2011), a Nigerian online recruiting technology study by Odumeru (2012) and others. To understand how the trialability of this mobile ticketing application affects its adoption intentions, it has been hypothesized as follows,

H4: *Trialability will make a significant impact on the behavioral intentions of the IRCTC commuters.*

Observability

According to Rogers (2003), observability is the measure of the degree to which the results of an innovation are clear or visible to others. This attribute has been found having a direct significant influence on the consumers' behavioral intentions in the following studies – technology products study (Vishwanath & Goldhaber, 2003), study on adoption of precision agricultural technologies (Rezaei-Moghaddam & Salehi, 2010), study on attitudes/intentions of experts in agricultural organizations (Ajili, Salehi, Rezaei-Moghaddam, Hayati, & Karbalaee, 2012). This attribute has therefore been hypothesized as,

H5: *Observability will make a significant impact on the behavioral intentions of the IRCTC commuters.*

Attribute-set II

Cost

Being one of the most frequently used innovation attribute, increased costs associated to the use of an innovation have always exhibited a very negative and significant impact on both the adoption

intentions, and in effect, the adoption of an innovation, for instance – meta-analysis of innovation attributes by Tornatzky & Klein (1982), mobile payments adoption study by Mallat (2007), mobile virtual network study by Shin (2010). An interesting illustration in this regard is a study by Shiu, Hassan, & Walsh (2009), on government policies for reducing smoking; it was revealed that a price increase led to accelerating the user intentions to quit smoking, which in effect was increased costs exerting a negative effect on the adoption intentions of potential smokers. Making railway bookings over a mobile phone come with an added charge of accessing the web using the phone's internet (data) plans. Therefore, the element of cost is valid in the case of our study.

H6: *Lower cost will make a positive impact on the adoption intentions of IRCTC commuters.*

Communicability

According to Gerpott (2011), communicability is the measure of the degree of simplicity with which the users of a given innovation are able to demonstrate the benefits of a new good to their respective social reference groups, in effect, making the results of a novelty observable to others. They also reported a positive significant relationship of this attribute on the adoption of mobile internet in their study. The literature shows that not many studies have chosen to pay attention to this attribute. In order to explore the effect of communicability on the adoption of the mobile ticketing application in the context of our study, this attribute was posited as follows,

H7: *Communicability will make a positive impact on the adoption of the IRCTC mobile ticketing application.*

Riskiness

Risk is often viewed to be a component having multiple dimensions, like the risk being either psychological, performance, social, financial, physical, or of time loss, or a combination of few or all of these different types of risk (Jacoby & Kaplan, 1972 cited by Rijsdijk & Hultnik, 2003). Much predictably, increased risks often exert a negative influence on both the intentions and actual adoption of an innovation. The past examples show that often security and privacy risks are associated to mobile related innovations – lack of internet security and privacy (Tan and Teo, 2000), e-commerce (Hansen, 2006), security and privacy risks in mobile marketing (Tanakinjal et al., 2010) and mobile ticketing studies (Mallat et al., 2008). The IRCTC ticketing application, also a mobile application needs to account for this adoption factor, and hence the hypotheses proposed for this attribute were directed both towards the adoption intention and the adoption of this application.

H8: *Riskiness makes a significant impact on the behavioral intentions of the IRCTC commuters.*

H9: *Riskiness makes a significant impact on the adoption of the IRCTC mobile ticketing application.*

Social Approval

According to Tornatzky & Klein (1982), social approval refers to a non-financial aspect of reward, which becomes indicative of the status gained by one in their reference group. Past studies have shown that social approval serves in positively influencing the intentions of the potential users of an innovation – wireless mobile data services adoption (Lu, Liu, Yu, & Wang, 2008), high technology innovations adoption (Kulviwat, Bruner II, & Al-Shuridah, 2009). In order to examine how favourable is the element of social approval in the context of the IRCTC mobile ticketing application, the proposed hypothesis is,

H10: *Social Approval will make a significant impact on the behavioral intentions of the IRCTC commuters.*

Attribute-set III

Voluntariness

According to Moore & Benbasat (1991), voluntariness is the measure of the degree to which the use of an innovation under consideration is perceived as voluntary, or of free will. They extend on this idea by reiterating that it is the perception of voluntariness, and not the actual voluntariness that influences the user behaviors. Innovations being introduced on a voluntary basis are accepted more easily in comparison to the mandatory adoption which tends to introduce resistance (Karahanna, Straub, & Chervany, 1999; Aubert & Hamel, 2001; Kishore & McLean, 2007). Innovation studies have observed this attribute having a significant impact on the adoption intentions - internet banking (Gounaris & Koritos, 2008), and mobile internet (Hsu et al., 2007).

H11: *Voluntariness will make a positive impact on the behavioral intentions of the IRCTC commuters.*

Image

According to Moore & Benbasat (1991), image is the measure of the degree to which the use of an innovation is seen to enhance one's image or status in their social system, and is assumed to have a positive association with adoption. Having a significant positive effect on the intention, this attribute makes its presence across different innovations - mobile internet adoption (Hsu et al., 2007), internet banking adoption (Gounaris & Koritos, 2008). The hypothesis thus formulated is,

H12: *Image will make a significant positive impact on the behavioral intentions of the IRCTC commuters.*

Result Demonstrability

According to Moore & Benbasat (1991), result demonstrability is a dimension of tangibility of the results associated with the use of an innovation, alongside its observability and communicability aspects. Greater the observability of and communicability of an innovation, higher are the chances of its adoption. This attribute, therefore, is often seen extending a positive significant influence on the adoption intentions - e-commerce adoption by Slyke, Belanger, & Hightower (2005) and Slyke, Lou, Belanger, & Sridhar (2010), mobile internet adoption by Hsu et al. (2007) are some examples of its significant behavior.

H13: *Result Demonstrability will make a significant impact on the behavioral intentions of the IRCTC commuters.*

Visibility

In analysing Rogers' illustration of observability, Moore & Benbasat (1991) arrived at an exclusive concept of visibility. Studies citing visibility as an innovation attribute often tend to acknowledge Moore & Benbasat (1991) for recognizing this attribute in its exclusivity (Hsu et al., 2007; Slyke et al., 2005). By definition, this attribute is the measure of the degree to which the use of an innovation becomes apparent. Studies have shown in their results that increased visibility of the benefits and use of an innovation tends to attract more users towards its use. Some examples are – the mobile internet study by Hsu et al. (2007), and the e-commerce study by Slyke et al. (2005). This attribute was thus included to investigate the existing usage level and its following influence on the attraction of more number of adopters for the IRCTC mobile ticketing application.

H14: *Visibility will make a significant impact on the behavioral intentions of the IRCTC commuters.*

Behavioral Intention

In addition to studying the influences of the shortlisted three attribute-sets, examining the influence of behavioral intention on the adoption of the IRCTC mobile ticketing application was deemed necessary, and hence this was included as the final innovation attribute for our study. According to Ajzen & Fishbein (1980), this attribute measures the probability of a subject in getting involved with a given behavior. Being regarded as an immediate determinant of actual adoption, it is observed to have a direct and positive effect on the actual use of an innovation (Chen, Gillenson, & Sherrell, 2002; Gumussoy & Calisir, 2009). Greater the behavioral intention, greater becomes the probability of innovation adoption. The proposed hypothesis therefore being,

H15 : *Behavioral Intention will make a positive impact on the adoption of the IRCTC mobile ticketing application.*

4. Research Method

4.1. *Survey Instrument*

A questionnaire approach for gathering the intended data was adopted. The survey questionnaire was made up of 68 questions in total. The circulation of questionnaires was done both, in person as physical copies, and as online using survey links. The format of these 68 questions varied, in that, eight of these were aimed at gathering demographic information, all being multiple choice by design, four of them focussed on respondents' personal information, and four of them focussed on respondents' use of the IRCTC mobile ticketing application. The other 60 questions of the questionnaire were the 7-point likert scale questions designed to measure the attitude of the respondents, across a range of responses, to different statements (Jamieson, 2004). The 60 questions effectively covered all of 13 shortlisted attributes of this study, and behavioral intention. Each attribute had four items to its account, meaning four different questions were asked to measure every innovation attribute, making 60 questions altogether. The 7-points on the likert scale that were used have been listed here - extremely disagree, quite disagree, slightly disagree, neutral, slightly agree, quite agree, and extremely agree. All 60 items are available in table 1, below, alongside the innovation attributes they belong to.

<div align="center">**--Table 1 Here: Attribute Specific Items Mapping**--</div>

4.2. *Pilot Study*

Post the survey instrument design, a pilot test was initiated for a small sample of 30 respondents. These 30 respondents were all Indian residents who were randomly chosen from different cities in India. Care was taken to ensure that the questionnaires were fairly distributed amongst respondents of different age groups to confirm unanimous understandability. In filling the questionnaires, the respondents were asked to raise any difficulties they may encounter in completing the questionnaires. In their feedback, all respondents confirmed for the ease of understanding, and clarity of the questions, but unanimously raised the issue of length of the questionnaire and the element of repetitiveness involved. A few other minor suggestions concerning the design of the questionnaire were made, that were quickly addressed and suitably amended. However, the length of the questionnaire was not compromised on, considering the importance of having four items per innovation attribute from the statistical analysis perspective. Therefore, the final questionnaire continued to comprise of all of the 68 questions, as present in the pilot version of the questionnaire.

4.3. *Data Collection*

To evaluate the adoption of IRCTC mobile ticketing in India, it was necessary to gather the data from all over India. Therefore, the data was collected from citizens residing in four most populous

Indian cities. In doing so, one city from each of the northern (Delhi City), eastern (Kolkata City), western (Mumbai City) and southern (Bangalore City) regions of India were identified. The citizens in these cities were then randomly reached out to, irrespective of them being the adopters or non-adopters of IRCTC mobile ticketing. A question on the circulated questionnaires asked the respondents if they were the adopters or the non-adopters of IRCTC's mobile ticketing application to measure its diffusion and awareness in the Indian context. The questionnaires were carefully and appropriately designed that made it convenient for both, adopters and non-adopters, to be able to provide responses from their respective perspectives. The questionnaires were distributed both as hard copies, and over the internet as an online web survey. Most respondents preferred filling the hard copies physically, rather than clicking responses online.

When it comes to selecting an appropriate sample size for regression analyses, whilst some recommendations in the literature suggest that a size of 300-400 is appropriate when moderate number of predictor variables are involved (Nunnally, 1978), the others recommend going by a 10:1 subjects to predictors ratio (Wampold & Freund, 1987). As addressed by Maxwell (2000), such discrepancies in the made suggestions have more often than not left the researchers confused about the appropriate sample size. However, for this research a safer number of 300+ was being aimed at. Given that four major cities in India were being targeted, the target number of 300+ was equally spread across these four cities, and rounded off at a minimum of 80 respondents from each city.

A realistic number estimate of 80 respondents per city was arrived at, bringing the total number of respondents to 320, for four cities altogether. We received a total of 398 filled questionnaires, of which 23 were incomplete. To maintain data validity, these incomplete responses were discarded, and the remaining 375 valid cases were then utilised for making statistical deductions for this study. Data analysis was carried out using the SPSS statistical analysis tool, the findings from which have been presented in section 5 of this paper; the section showcases results from different tests that were undertaken - *frequency tests* for the demographic features, *reliability test* for measuring the internal consistencies of the different items making up the shortlisted innovation attributes for this study, *descriptive test* yielding the means and standard deviations of these attributes, *regression analyses*, both, *linear* and *logistic*, to test the proposed hypotheses, and finally, the *multicollinearity test* to test the correlation amongst the different predictor attributes of the study.

5. FINDINGS

5.1. *Frequency Tests*

The frequency tests were run in two parts. While the first run concentrated on the respondents' personal profile, which is their age, gender, and educational qualifications (table 2), the second run maintained focus on the usage of the IRCTC mobile ticketing application, which was to do with the type of application provider, the time span since the application was in use by the respondents, and lastly, the frequency of their usage (table 3). The test results showed that the highest populated age category was the 18-24 group with 38.7% of respondents. The female category was found to be slightly higher in number with 201 respondents out of the total 375. Qualification wise, a large chunk of respondents were graduates with 48.8% belonging to this category.

--Table 2 Here: Frequency Test: Run-I--

On the other hand, the second run revealed that a very high percentage of the respondents were non-adopters (77.9%) indicating a poor adoption rate of this application. Out of the remaining 22.1% adopters, most of them preferred Paymate as their application provider (14.1%), who had mostly been using this application since less than a year (10.4%), with a very less usage frequency (9.6%).

--Table 3 Here: Frequency Test: Run II--

5.2. *Reliability Test*

To confirm the internal consistencies of different items forming each of the shortlisted innovation attributes for this study, a reliability test results was undertaken (table 4). For reading the different reliability types, we adopted the scale ranges set by Hinton, Brownlow, McMurray, & Cozens (2004), whereby, the *Cronbach's alpha* values ≥ 0.90 would be read as the excellent reliability type, those falling in the range 0.70-0.90 would be read for high reliability, similarly those in the range 0.50-0.70 represented moderate reliability, and finally, all values ≤ 0.50 would be read for low reliability type. Out of the total 14 attributes, nine underwent the deletion of one item each to arrive at better Cronbach's alpha values. The results from the test clearly show that whilst three attributes exhibited excellent reliability, eight represented high reliabilities, and three represented moderate reliabilities, none were found with a low reliability. Of all the attributes, *behavioral intention* was found displaying the highest Cronbach's alpha value at 0.912.

--Table 4 Here: Reliability Test--

5.3. *Descriptive Statistics*

In deducing the mean and standard deviations for the individual innovation attributes, a descriptive statistics test was run (table 5). The table is also populated with the standard deviation for all attributes. The results of this test have been arranged in the ascending order of the mean values in the table, below. While *image* was the attribute with the lowest mean value at 3.53, *relative advantage* scored the highest mean value at 4.69.

--Table 5 Here: Descriptive Statistics: Importance of innovation attributes--

5.4. *Regression analyses*

Four runs of regression analyses were undertaken, while three of these runs corresponded to the linear regression runs for all of the three attribute-sets, one logistic regression run was undertaken. A multicollinearity test was also run to check for the multicollinearity problem with the innovation attributes. All these tests were run on all of the 375 valid cases for this study. All of the aforementioned test runs have been elaborated with the test results in the paragraphs that follow.

5.4.1. Linear Regression I – Testing the influence of the innovation-attributes from the DOI theory on the behavioral intentions of the IRCTC commuters.

According to Worster, Fan, & Ismaila (2007), linear regression undertakes an assumption that the dependent and independent attributes share a linear relationship amongst them. For the first linear regression run, the five attributes from the attribute-set I were the independent variables and behavioral intention was the dependent variable. The results of this regression run showed that the resultant model successfully and significantly predicted the commuters' behavioral intention towards the use of the IRCTC mobile ticketing application: (F (5,375) = 64.832, p=0.000) (Table 6). The model was also seen successfully explaining 46% of the variance, with the adjusted R^2 value being at 0.460. Another important deduction from this test revealed that four of the five independent attributes behaved as the significant predictor attributes, and one attribute, complexity, failed to significantly predict the behavioral intention (□□□□□□□□p=0.400).

--Table 6 Here: Linear Regression I--

5.4.2. Linear Regression II – Testing the influence of innovation-attributes from Tornatzky and Klein's meta-analysis on the behavioral intentions of the IRCTC commuters.

In this linear regression run, while the four attributes from the attribute-set II were considered as the independent attributes, behavioral intention continued to be the chosen dependent attribute (Table 7). Also being a significant resultant model: $(F (4, 375) = 83.381; p=0.000)$, this model explained 46.8% variance (adjusted $R^2=0.468$). As the results indicate, all attributes from the second attribute-set proved to be significant predictor attributes.

--Table 7 Here: Linear Regression II--

5.4.3. Linear Regression III – Testing the influence of innovation-attributes from the PCI theory on the behavioral intentions of the IRCTC commuters.

In the third linear regression run, the four attributes from the attribute-set II were chosen to be the independent attributes, and behavioral intention, again was the dependent attribute (Table 7). The results for this run also concluded for a resultant model that significantly predicted the commuter intentions: $(F (4, 375) = 75.773; p=0.000)$, explaining 44.4% variance (adjusted $R^2=0.444$). All four attributes in this run were found to behave as the significant predictor attributes.

--Table 8: Linear Regression III--

5.4.4. Multicollinearity Test

According to Brace et al. (2006), a multicollinearity situation often hinders the examination of the roles of different predictor variables when a high degree of correlation is detected amongst two or more predictor variables that are being used in a study. From the result tables of the three linear regression runs, above, it is apparent that simultaneous multicollinearity tests were also undertaken, the values of which are available in the VIF columns in tables 6, 7 and 8. According to (Irani, Dwivedi, & Williams, 2009), any value below the maximum allowed of 10 confirms that the tested predictor variables are free of the multicollinearity problem. The values in the tables confirm that all VIF values fall within the 1.1 - 2.9 range, which is much lower than the maximum value of 10. Therefore, the attributes of this study are concluded as not suffering a multicollinearity condition. This in effect is suggestive of the idea that there is a high probability that the variance explained by the 13 innovation attributes being used as the predictor variables in our study, is very close to the real situation.

5.4.5. Logistic Regression – Testing the influence of behavioral intention and riskiness on the adoption of the IRCTC mobile ticketing application.

According to Worster et al. (2007), logistic regression assumes that the outcome variable is dichotomous, that is, it has two probable outcomes. This run for logistic regression used adoption as the dependent attribute, and behavioral intention and riskiness as the two independent attributes (table 9). The results indicated that the resultant model significantly predicted the adoption of the IRCTC mobile ticketing application (omnibus chi-square=25.302, df=2, p=0.000).

--Table 9 Here: Omnibus Tests of Model Coefficients--

As shown in table 10, the model accounted for a variance between 6.5% and 10% in the adoption decisions of the mobile ticketing application.

--Table 10 Here: Model Summary--

Table 11, on the other hand, is representative of the statistics that state that 100% of the non-adopters, and only 18.3% of the adopters were successfully predicted by this model. The model gave 82.1% of accurate predictions, overall.

--Table 11 Here: Classification Table--

With the coefficient values, Wald statistics, degrees of freedom, and probabilities for behavioral intention and riskiness showing favourable statistics, it was concluded that these two attributes significantly and reliably predicted the IRCTC mobile ticketing application adoption in the Indian context (table 12).

-- Table 12 Here: Variables in the equation--

6. DISCUSSION

6.1. *Testing proposed hypotheses and research model validation*

The study proposed 15 hypotheses, altogether, and the test results as made available in section 4 revealed that 14 of these hypotheses were confirmed true and supported by the gathered data. Only one hypothesis, H3 was not supported. The statistics in tables 6, 7, 8 and 12 revealed that relative advantage, compatibility, trialability, observability, voluntariness, image, result demonstrability, social approval, visibility, cost, riskiness and communicability significantly predicted the use intentions of the IRCTC commuters towards the IRCTC mobile ticketing application. On the other hand, behavioral intention and riskiness significantly predicted the adoption of the mobile ticketing application. Complexity was found to be the single insignificant attribute, which failed to predict the use intentions for this mobile application.

Paying primary attention to the sole non-significant attribute in this study, this part of the section attempts to understand the insignificant behavior of *complexity* in the IRCTC mobile ticketing context. Complexity displayed a non-significant effect on behavioral intention at a p-value of 0.4. Such behavior of this attribute turns out to be opposing of its conventional influence on behavioral intention. Numerous studies support the significant effect of complexity on use intentions, nonetheless, there are studies from the past that have reported non-significant relationships between complexity and behavioral intention, much in line with the results from our study; for instance, online banking adoption study by Pikkarainen, Pikkarainen, Karjaluoto, & Pahnila (2004); mobile banking adoption study by Koenig-Lewis et al. (2010). By definition, complexity is the attribute which measures the degree to which an innovation is perceived of being difficult to understand and use. Deviating attention to the respondent population of our study, the numbers in table 2 showed that the largest proportion of our respondents belonged to the 18-34 age group (74.7%), with most of them being well educated (48.8% graduates). Very much evidently, these respondents are young, and very well acquainted with the modern-day technologies and their know-how. In a time when almost everything is operated on the web, and internet and mobile phones are an integral part of everyday lives, using applications on a mobile phone has become a regular affair. The same can be applied to the use of a simple application like the IRCTC mobile ticketing application, which clearly is not being perceived as challenging by this generation. This in turn gives a probable explanation for, why the respondents did not find the issue of complexity any concerning in this regard and hence its insignificance. The following paragraphs will now detail on the significant predictor attributes, attribute-set wise.

Attribute-set I

Four of the five innovation attributes in the attribute-set I, adopted from Rogers' DOI theory displayed significant relationships with behavioral intention. To begin with, the hypothesis extended for relative advantage, H1 was concluded true for our study. This finding is very much in line with the past studies that have confirmed a significant and positive influence of relative advantage on consumers' use intentions. Studies such as the meta-analysis by Tornatzky & Klein (1982), e-government adoption study by Carter & Belanger (2005), multimedia messaging service adoption study by Hsu et al. (2007), mobile payment services adoption study by Schierz et al. (2010), mobile internet adoption study by Grepott (2011) and many others supported this significant behavior of relative advantage. The IRCTC mobile ticketing application is relatively advantageous than the over-the-counter and online booking systems in several ways – its biggest advantage being, it being mobile, giving the commuters a flexibility of making railway bookings from anywhere, at any time, using the data network from their mobile phone providers. It eliminates the need for accessing a Wi-Fi router point, or even a laptop/personal computer, as the application on the mobile phones easily serves both these purposes. The time required for making a booking is reduced physically, as walking into the physical offices and queuing at the counters to make bookings can be avoided with this application. Also, a simple tap on the mobile phone lets the users into the application to access their travel schedules, without having to go through logging in with their credentials each time, after having to access the IRCTC official webpage. Our empirical data is in accordance with these aforementioned facts, as the statistics from the various undertaken tests revealed that the commuters perceived this mobile application to be fairly advantageous than the other two existing railway ticketing options.

The second attribute in this set was compatibility, which exerted a favourable positive influence on the commuters' behavioral intentions. Hypothesis, H2 was thereby declared true. Evidences from the past literature confirming this effect of compatibility are studies like the smart cards adoption study by Aubert & Hamel (2001), virtual stores use intentions study by Chen et al. (2002), groupware application adoption study by Slyke, Lou, & Day (2002), anti-spyware software adoption study by Lee & Kozar (2008), mobile ticketing services adoption study by Mallat et al. (2008) and many more. The IRCTC mobile ticketing application was found to be compatible with both, the users' lifestyles, and their railway ticketing needs. In elaboration, the application successfully runs on both the CDMA and GSM mobile phones, either of the two is used by a big majority of the citizens, and like the counter and online systems of ticketing, the mobile applications allows commuters to pull up railway schedules, view price lists and make ticket payments in a much faster and economical manner. Again, the above argument is supported by the gathered data, in that, the respondents' voted for this mobile application to be compatible, overall.

Following next are hypotheses, H4 and H5, which confirmed that trialability and observability have a significant influence on the commuters' use intentions. The following studies reconfirm this positive behavior of these two attributes in their test results – self service technologies adoption study by Meuter et al. (2005), internet banking adoption study by Suki (2010), consumer innovation adoption study by Arts, Frambach, & Bijmolt (2011), e-book reader adoption study by Jung, Chan-Olmsted, Park, & Kim (2011) and others. Being a mobile application, this technology comes with no kind of installation or a fixed term usage clause. The commuters can try this application for as long as they wish, and terminate its usage at any time without any obligation towards the service providers. There is no trial period for this application or in other words, it comes with an unlimited trial period, making it more attractive to the customers who are free to explore its usage at their own terms. Being confirmed for positive effects of observability, the users have clearly witnessed the usage of this application and made positive perceptions of it, as supported by the empirical data.

Attribute-set II

All four attributes of the second set also had the data supporting the proposed hypotheses. As proposed, the low cost association positively impacted the use intentions of the commuters (H6: Supported). With no additional cost associations in making the railway bookings on the mobile phone application, this technology has obviously been perceived as a cost-effective solution for convenient railway ticketing. Although, the commuters may incur a small data usage charge from the mobile network provider for accessing the internet, these data plans come covered at very affordable prices combined with the users' monthly talk-minutes plans. Some past study examples for the positive influence of this attribute on use intentions are – organizational innovations adoption study by Damanpour & Schneider (2009) and mobile virtual network adoption study by Shin (2010). Communicability also had the hypothesis (H7) association to it being concluded true. The test results are indicative of the fact that the current users of the IRCTC mobile ticketing application find communicating to the others the positives of its use, very easy, which in turn influences the potential commuters to form positive intentions about its usage. Riskiness, on the other hand was studied for its influences on both, adoption intention and adoption. The hypotheses, H8 and H9 were found true with riskiness displaying a significant influence on the commuters' adoption intentions and adoption decisions, which is in line with the findings from other studies - for instance, an internet consumer behavior study by Taylor & Strutton (2010), a mobile ticketing service adoption study by Mallat et al. (2008), a mobile payment study by Chen (2008) and others. Lastly, social approval also behaved as a significant predictor variable of commuters' behavioral intentions (H10). Past studies also approve of this behavior for this attribute in their study results (Lee-Partridge & Ho, 2003; Mallat et al., 2008). The positive approval and acceptance of this application by its current adopters apparently has a positive influence on the perceptions of its potential adopters.

Attribute-set III

All innovation attributes from this set, adopted from Moore and Benbasat's PCI theory were seen sharing a significant relationship with the behavioral intentions of the IRCTC commuters, rendering hypotheses H11, H12, H13, and H14 true. With voluntariness having a positive influence on consumer intentions, the empirical data confirms that the element of free will in the use of the IRCTC mobile ticketing application is clear to the IRCTC commuters, and that it also has a favourable effect on their use intentions. In making railway bookings, the commuter has a choice of confirming ticketing at the counter, on the internet, or on the mobile application. The absence of any mandate that makes the mobile ticketing application being made the only single ticketing solution is well perceived by the users. Studies on adoption of smart cards (Aubert & Hamel, 2001) and internet banking (Gounaris & Koritos, 2008) have also confirmed for this behavior. Image, as an innovation attribute worked positively in influencing consumer intentions. Past studies such as the web-based shopping adoption study by Slyke, Belanger, & Comunale (2004), e-government adoption by Carter & Belanger (2005) multimedia messaging service adoption study by Hsu et al. (2007) and many others have confirmed for this influence on image. The commuters may be viewing the use of this mobile ticketing application as a social status indicator, and may be using it to enhance their image in their social groups. By definition, observability and communicability together make result demonstrability. Both these attributes were exclusively analysed (hypotheses H5 and H7) in our study and were found showing a significant effect on the use intentions of the commuters. The test results showed that the potential commuters could form positive intentions about the IRCTC application by easy observation of its use and by the positive reviews that were communicated to them by the active users of this mobile ticketing application. Visibility was also significantly influencing the commuter intentions of using this ticketing application. In line with our study's results are these studies from the literature – e-commerce adoption study by Slyke et al. (2005) and MMS adoption study by Hsu et al. (2007) that confirm that the use of a technology being apparent helps influence the user intentions positively.

Having discussed attributes from all three attribute-sets, the very last hypothesis, H15 for this study was also rendered true, with behavioral intention positively and significantly impacting the adoption decisions of the IRCTC mobile ticketing application. Several instances supporting this relationship are available in the existing literature (Ajzen, 1991; Taylor & Todd, 1997; Lee & Kozar, 2008; Shin, 2010). The favourable consumer intentions towards the use of this mobile ticketing application influenced significantly the adoption of this application in the Indian context.

### 6.2.	*Validating the Three Attribute-sets*

The adjusted R^2 values for behavioral intention were deduced for all the three attribute-sets. The attribute-set I derived a value of 0.460 in the regression test results. When these R^2 values were compared with the R^2 values derived by the past studies, it was found that studies analysing the influence of one or more or all of the DOI attributes on behavioral intention were almost equivalent to, or a little higher, in comparison to the values reported in our study for the attribute-set I. For instance, whilst Li, Troutt, Brandyberry, & Wang (2011) reported an adjusted R^2 value of 0.45, Hsu et al. (2007) reported a slightly higher value of 0.524, as did Mallat et al. (2008) with a value of 0.555. Therefore, it can be concluded that the attribute-set I model delivered a satisfactory performance as a model for studying the mobile ticketing innovation adoption. In a similar analysis for the attribute-set II derived an adjusted R^2 value of 0.468. When compared with past publications, it was seen that Grepott (2011) found an R^2 value of 0.225 in their study, Lee-Partridge & Ho (2003) reported 0.320, which are both lesser than the values reported in our study, making this attribute-set, a well performing one too. Finally, for attribute-set III, the reported R^2 value was found to be 0.444. In comparing with studies from the past that studied the innovation attributes similar to those used in our third attribute-set, it was found that the value reported by our study was higher than the earlier studies. For example - Karahanna et al (1999) showed an adjusted R^2 value of 0.384; Kishore & McLean (2007), on the other hand, reported a value of 0.43. This also led us to conclude that the attribute-set III also delivered satisfactory performance in predicting the adoption intentions for the IRCTC mobile ticketing application. Overall, all three attribute-sets were revealed to have served almost equally well, as innovation-adoption models, in predicting the commuters' behavioral intentions.

In evaluating adoption, two R^2 values, Cox and Snell R^2 and Nagelkerke R^2 were derived in the logistic regression run. The values for our study were, Cox and Snell R^2 at .065, and Nagelkerke R^2 at .100. The R^2 values for both were found to be notably lesser than the Cox and Snell and Nagelkerke values from the past studies, for instance - Cox and Snell = 0.379 and Nagelkerke = 0.538 by Li (2008); Cox and Snell = 0.51 and Nagelkerke = 0.69 by Wang, Wang, & Yang (2010). This value comparison led to conclude that the variance in adoption is not very well explained by the riskiness and behavioral intention associated with the IRCTC mobile ticketing application in the Indian context.

### 6.3.	*Practical Implications*

The results showed that compatibility and relative advantage from attribute-set I, cost and social approval from attribute-set II, and result demonstrability and voluntariness from attribute-set III were the strongest predictors of adoption intention. Also, riskiness strongly predicted the actual adoption. From the managerial perspective, these strong influencers suggest that the developers of this technology should place more emphasis on - its ubiquitous feature making it usable on-the-go and being time effective in return; ensure clear demonstration of the benefits and ease involved with its use; build on the idea of free will of usage and how its usage introduces an element of convenience in making railway bookings; highlight how cost-effective the application is and also demonstrate the minimal/low cost associations with its use; make efforts in increasing consumer awareness to attract more users, who in turn will release a snowball effect, wherein, the potential adopters will be attracted towards its use upon watching the adopters savouring its benefits and

spreading a positive word on its use; and lastly, assure users of it being a low risk technology, with stringent security and privacy policies being taken care of, in the interest of the consumers.

Despite the identification of numerous factors that positively influenced the adoption intentions and adoption of this application, as the statistics have it, it was seen that with only 22.1% adopter population to its account, this application suffered a very poor adoption rate. As mentioned earlier, this is a recent technology, continuously evolving and slowly diffusing in the target market. Owing to the fact that this mobile application is competing in a market which has alternative railway ticket booking systems (counter and online bookings) with the use of which the IRCTC commuters are already comfortable, it becomes imperative to work on introducing more attractive features with this application to draw more number of users towards its use over the other two preceding systems already in use. The advantages of this mobile ticketing application require well-thought advertising which will help potential users perceive this application, as adaptive and fitting with their lifestyles and railway booking needs.

7. Conclusions, Contributions, Limitations and Future Research Directions

With this study on the adoption of the IRCTC mobile ticketing application in an Indian context, we tested and validated an established set of notions by analysing the behavior of 14 innovation attributes altogether, for their influence on the adoption intentions and adoption of the aforementioned mobile application. Three noteworthy attribute-sets (Rogers' Diffusion of Innovations theory, Moore & Benbasat's perceived characteristics of innovating theory, and Tornatzky & Klein's meta-analysis) were used to study their influence on the mobile ticketing adoption. Care was taken to prevent any overlap of innovation attributes amongst the three chosen attribute-sets. 14 of the 15 proposed hypotheses were supported by the empirical data and the statistical tests from the SPSS analysis. The key conclusions from this study have been summarized here – other than complexity, the remaining four attributes from the DOI theory proved to have a significant influence on behavioral intention; in the interest of preventing overlapping attributes, ease of use was discarded from the set of attributes borrowed from the PCI theory; all attributes from attribute-set II (meta-analysis by Tornatzky & Klein) and from set III (PCI theory) were also proven to have a significant influence on behavioral intention. Riskiness being studied for its influence on both, intention and adoption, was found to significantly affect both the dependent variables; behavioral intention, on the other hand, also positively influenced the actual adoption of the IRCTC mobile ticketing application in the Indian context; the adjusted R^2 values for behavioral intention revealed that the attribute-set II performed most satisfactorily with an adjusted R^2 value of 0.468, followed next by attribute-set I with a value of 0.460, and last, by attribute-set III with a value of 0.444.

7.1. *Research Contributions*

The findings from this study extend contributions to existing literature on innovation-attributes from three sources – Rogers (2003), Tornatzky & Klein (1982), and Moore & Benbasat (1991) for their influences on the adoption intentions and the actual adoption, in a whole new context of diffusion and adoption of the *IRCTC mobile ticketing application* in the *Indian context*. The absence of literature on the acceptance of this mobile ticketing application in the Indian context makes the deductions and conclusions from our study all the more enriching from the perspective of future research on this technology. Studying the behavior of 13 noteworthy innovation attributes on the behavioral intention, alongside the effects of behavioral intention and riskiness on adoption, these findings present a foundation or base, which the future researchers could use to build upon by modifying and proposing new models that would help extract further information on the adoption factors of this application. With the growing concept of ubiquitous services, concepts of mobile wallet, paperless transactions, and reducing the need of staff at physical offices, mobile applications such as the IRCTC mobile ticketing application need to be promoted in a way that attracts wider

adoption. In doing so, understanding the factors that steer its diffusion and actual acceptance becomes important, and the findings from our study attempt to offer the practitioners of this technology a solution in the form of constructive information on its adoption factors impacting its acceptance.

Finally, it is apparent that the research and practice on the mobile ticketing application in the Indian context is still in its beginning years, and the opportunities in terms of research, business processes, and consumer behavior are enormous, today. The testing and validation of the conceptual model in this paper for investigating the IRCTC mobile ticketing acceptance, sets in motion the theory and research on one of the important and progressive technologies of today's world.

7.2. *Research Limitations*

In terms of identifying the limitations, our data collection strategy identified and targeted only four states out of the 28 Indian states, in total. Giving consideration to the fact that cultural and geographical factors tend to influence the diffusion of an innovation, it may be worthy to target more number of cities altogether with an aim of placing attention in the probable effect these cultural differences may have on the adoption of this mobile ticketing application in India. The future researchers may thus consider probing into state wise differences in the adoption rate for an internal comparison and much detailed understanding of the factors that influence the diffusion of this application in the Indian context. In discussing the influences of riskiness and delving into the past studies, it was revealed that riskiness is a multidimensional component. For instance, Gupta & Xu (2010) emphasized that many different kinds of risks are associated with the use of a technology. Although, our study had it significantly impacting the adoption intention and adoption, not until the effect of these different risk types are learnt, can the actual influence of riskiness be validated. Therefore, it should be interesting to witness the future research concentrating on the all of the possible different risk types that could be associated with the use of the mobile ticketing application to explore the total influence of riskiness as an innovation attribute.

Our study picked attributes from three different sources that have extended valuable contributions in the field of innovations. However, it cannot be denied that there are many other innovation attributes that have been found to considerably influence the use intentions and actual use of any innovation. To name a few, we have, self efficacy, subjective norms, trust, facilitating conditions, and so on. Future researchers may want to study the influences of these other innovation attributes on the IRCTC mobile ticketing application to add value and statistical support to the literature on its adoption and diffusion. As highlighted in the discussions section, Cox and Snell and Nagelkerke R^2 values from the logistic regression run for this study were found to be very low in value indicating a less satisfactory explanation for the variance of the proposed model analysing the effect of behavioral intention and riskiness on the adoption of the mobile ticketing application under consideration. Studying more number of innovation attributes for their influence on the adoption of the application may help overcome this problem and therefore, the future researchers should consider suitably modifying their adoption models for inclusion of more innovation attributes.

To conclude, we reiterate here that the diffusion of this application in the Indian context is still in its early, evolving stages, which clearly opens the possibility of the behavior of these studied innovation attributes to change over time. This in effect requires running an analysis for the influences of these innovation attributes, again, at a future time. Results from such repeated studies may produce interesting revelations on how some of these attributes may behave differently over time, or may even confirm these older results with zero change in their behavior, helping us better understand the influence of the time factor in this regard.

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