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User Acceptance of Pervasive Information Systems: Evaluating an RFID Ticketing System

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USER ACCEPTANCE OF PERVASIVE INFORMATION SYSTEMS: EVALUATING AN RFID TICKETING SYSTEM

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Abstract

Pervasive Information Systems (Pervasive IS) constitute an emerging class of Information Systems in which Information Technology artefacts are embedded in the physical space, working together to sense and communicate user related and environmental information, and supporting user tasks and activities unobtrusively. Drawing from the novel properties of Pervasive IS, this study seeks to investigate whether the extant IS user acceptance theories may adequately predict user behaviour within pervasive environments. The theoretical background of the study was drawn from the technology acceptance model (TAM) and the innovation diffusion theory (IDT) and enhanced with factors related to privacy and switching cost features. The research model was tested with data gathered through a lab experiment (N=71). The participants perceived the system as useful and easy to use, and expressed the willingness to adopt it should it become commercially available. The results from a multiple regression analysis suggest that the salient beliefs of the technology acceptance model, namely perceived usefulness and ease of use are still strong predictors of user behaviour towards actual Pervasive IS use. Conversely the remaining factors such as perceived risk and attractiveness of alternatives do not seem to hold significant power in predicting user behaviour in the Pervasive IS domain.

Keywords: user acceptance, technology acceptance model, Radio Frequency IDentification, Pervasive Information Systems

1 INTRODUCTION

The advent of mobile and wireless technologies such as Wi-Fi, ZigBee (Geer, 2005), and RFID (Smith et al., 2003) challenge our traditional view of Information Systems (IS) by envisioning new ways of interacting with them away from the boundaries imposed by the desktop computer. IS scholars have treated this new phenomenon by employing different terminologies, such as nomadic computing (Lyytinen et al., 2002), ubiquitous computing (Weiser, 1993), and pervasive computing (Saha et al., 2003). These terms share the common denominator that Information Technology (IT) pervades the physical space, operates in the periphery of human lifeworld, and may support a variety of applications and services in a context-aware and passive manner. *Context-awareness* implies that the system may be capable of perceiving environmental or user-related information and adapting its features or functionality respectively. *Passiveness* implies that humans may not always trigger the interaction with the system. Instead, the system may dynamically perceive the needs and wants of its intended users and initiate a system response to an unprompted request.

Birnbaum (1997) positioned these novel characteristics in the IS discipline by defining a new IS class entitled Pervasive Information Systems (Pervasive IS). Pervasive IS may support both personal and business activities. Indicative examples include the smart home (Intille, 2002) and the smart museum (Hsi et al., 2005). Kourouthanassis and Giaglis (2006) provide a taxonomy of Pervasive IS and their features by identifying four pertinent application types: personal, domestic, corporate, and public.

The present study aims at investigating whether extant user acceptance theories are adequate to assess and predict user behaviour and subsequent attitude towards Pervasive IS usage. The need to predict user acceptance in Pervasive IS environments stems from the very nature of Pervasive IS users, which differs from stationary, desktop-based, environments. Pervasive IS users may range from being vaguely familiar with IT to expert users. At the same time, they may be opportunistic in the sense that they may only use sporadically the system and will, most probably, not be subjected to proper training. As a result, formative and summative evaluation of Pervasive IS is a real challenge for IS researchers. Although IS evaluation has been one of the most popular research topics with several models or frameworks attempting to explain the adoption and use of IT services [e.g. (Venkatesh, 2003; Goodhue et al., 1995)] the novel features of Pervasive IS raise significant challenges in terms of understanding the factors that influence Pervasive IS acceptance and selecting appropriate usability engineering methods.

For example, the Technology Acceptance Model (Davis, 1989), including its extensions over the past years, considers a system's ease of use and usefulness as the core determinants of the likelihood to be accepted and, eventually, used. This might be true in desktop environments where there is one-to-one association between the user and the system and task-centric evaluation is possible. However, Pervasive IS may have a broader user base, more and different uses, and more demanding user expectations placed upon them. The term 'user' may be inappropriate to characterize humans' role while interacting with Pervasive IS. Thomas et al. (2002) use the term 'digital consumer', but we believe that this is just one of many alternative human roles, which may also include role models such as 'citizen', 'individual', and 'employee' to name but a few. Each role may have different perceptions on the factors that influence the performance and utility of the Pervasive IS. Likewise, the fact that humans may actively participate and benefit from Pervasive IS services without consciously 'using' them makes it even harder to adopt the existing evaluation frameworks proposed in the IS literature per se.

Drawing from this objective, the present study aims at predicting technology acceptance of Pervasive IS by employing a hybrid model that incorporates factors from established traditional IS user acceptance theories. Our intention is not to propose a new model, but, instead, to assess whether the examined factors are adequate to measure user acceptance of the new IS class. Thus, we have developed a pervasive system and evaluated it in laboratory conditions. Section 2 briefly presents the system architecture and design rationale. Section 3 presents the development of an appropriate measurement model to assess the acceptance of the system. Sections 4 and 5 discuss the preparation activities and results of the lab experiment. Finally, section 6 provide a discussion and concluding remarks identifying the pertinent theoretical and practical implications of the proposed solution.

2 PERVASIVE SYSTEM ARCHITECTURE

The need for faster and more accurate transactions has driven the ticketing market towards the use of innovative technologies and practices. Electronic ticketing is today a commodity in areas like entertainment (cinemas, theaters, and amusement parks to name but a few), sport events, public transportation, parking lots, automotive toll collections, and airline control. The technologies most commonly used are magnetic stripe tickets/cards, electronic tickets via internet, mobile ticketing systems, and smart cards. The advantages of these systems are cashless and queue-less transactions, payments through flexible ways (e.g. by sending an SMS), reduction in operating and maintenance costs due to little or no manual intervention, accurate access control resulting in reduced number of fare dodgers and in anti-counterfeiting, and efficient cost accounting with the potential of offering variable ticket pricing. ***Table 1*** provides an overview of these approaches.

Table 1: Technology-based Ticketing Systems

Technology	Functionality	Application Area	Advantages	Disadvantages
Magnetic Stripe Ticketing	access privileges and fare remaining are included and magnetically recoded after each use	commonly used to sports events and public transportation	technologically simple and inexpensive to produce	relatively small amount of information and may be easily read and copied
Electronic Ticketing	tickets are reserved or bought through a website (internet) or by telephone. Once a reservation is made an e-ticket exists only as a digital record in the computers so customers usually print out a copy of their receipt which contains the record locator and the e-ticket number	commonly used to airline flights and entertainment venues	cheap and efficient method, 24/7 accessibility	requires customers who knows how to use computers and how to access the internet
Mobile Ticketing	mobile ticketing consider the mobile phone as the payment device. The reservation and actual payment may occur through exchanging an SMS message or submitting a request through the mobile network.	commonly used to parking lots, toll collection, and public transportation	cheap and efficient method	not a familiar method to the public
Contact Smart Cards	an embedded microprocessor and memory allows to save and manage access privileges and fare remaining	commonly used to sports events, public transportation and entertainment venues	programmable medium capable to offer advanced services (such as discounts, offers etc.)	expensive, requires sophisticated infrastructure and hinders security implications
Contactless Smart Cards	an embedded microprocessor and memory allows to save and manage access privileges and fare remaining, an embedded antenna gives the ability to communicate wirelessly with the infrastructure	commonly used to sports events, public transportation and entertainment venues	programmable medium capable to offer advanced real time ticketing services (such as discounts, offers etc.), time saving transactions	expensive, requires sophisticated infrastructure and hinders security implications

Table 1 Technology-based Ticketing Systems

This paper presents an innovative ticketing architecture that draws from the aforementioned practices and aims at further enhancing the efficiency of ticketing systems. In particular, we propose an RFID-based ticketing system (henceforth referred to as SEAT) that may be employed to control access in any type of athletic events. RFID (Radio Frequency IDentification) is a generic term for technologies that use radio waves to automatically identify people or objects (Finkenzeller, 2003).

The SEAT ticketing system manages all operations related to issuing and selling tickets, and furthermore controlling access for athletic events hosted in stadiums. The system functionality is based on an RFID-enabled personal debit card (contactless smart card). The RFID card enables fans to purchase tickets from automated ticket kiosks and to enter the stadium through gates that provide automated access control. Furthermore, the system offers value-added services in the form of cashless transactions in the stadium, real time traffic information for the sport club, and personalized services to fans.

SEAT follows a 3-tier architecture based on distributed systems principles (Tanenbaum et al., 2003), supporting wide geographic dispersion of the system resources, independent modules providing the services, and central data storage and data access. The system consists of four distinct components:

- An RFID contactless smart card that stores important information regarding remaining price units and stadium access rights (operating at 13.56 MHz and supporting ICODE 1, 48 bytes read/write memory).
- An RFID reader (connected to the workstation) that reads/writes the RFID card and communicates all the information from and to the workstation (13.56 MHz frequency, supports ICODE 1, read/write capability, RS232 connectivity).
- Workstations (personal computers or laptops) that host a software module relative to the service provided (registration, kiosk, access control).
- A server that manages the database read/write access and the readers (identification).

Figure 1 illustrates the system architecture.

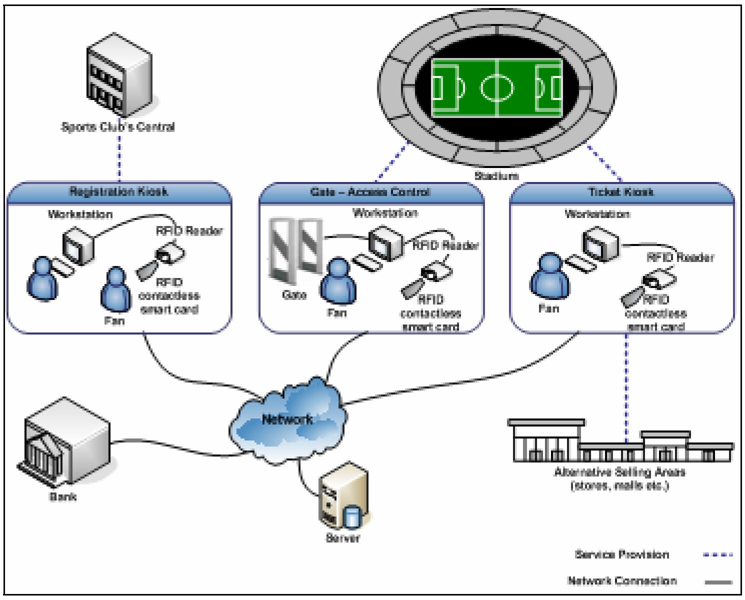

Figure 1 RFID Ticketing System Architecture

In a typical usage scenario, a spectator of the athletic event issues an RFID contactless smart card from the registration kiosk (a one time registration) and charges it with a specific amount (see Figure 2).

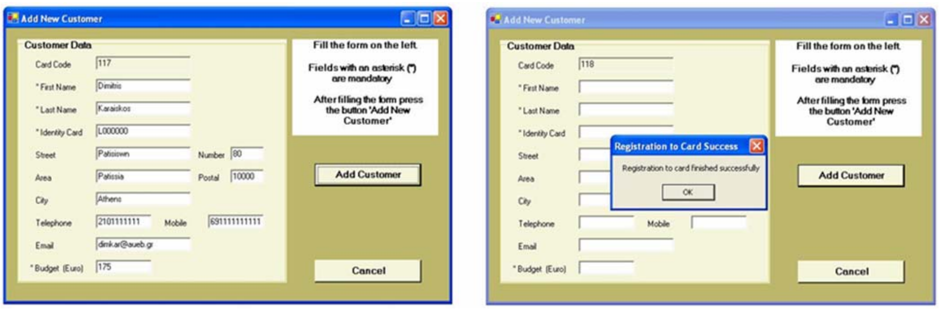

Figure 2 Registration Kiosk: customer data form and registration's confirmation screen

The spectator can then go to a ticket kiosk and purchase a ticket for the event of his preference by swapping or placing the RFID card near the reader that is attached to the ticket kiosk. For security and authentication purposes a PIN number is requested (see Figure 3).

Figure 3 Ticket Kiosk: welcome and PIN code authentication screen

Finally the spectator can enter the stadium by swapping or placing the RFID card near the reader that is attached to the gate's turnstile. Once more, the PIN number is requested for security and authentication purposes. All system components have been developed following the .NET framework. Interfaces with the RFID reader have been developed using the corresponding SDK, and have been programmed in VB.NET. To measure the perceived acceptance of the proposed solution, we performed a lab experiment in which a representative set of spectators of athletic events where invited to use and assess the implemented prototype. Drawing from established theories that measure IS acceptance we developed an integrated research model and a set of corresponding hypotheses. The following section discusses the rationale and development of our research model.

3 RESEARCH MODEL AND HYPOTHESES

One major research stream in IS literature is that of the technology acceptance [e.g., (Davis, 1989; Hartwick et al., 1994; Venkatesh, 2003)]. Researchers in this area have adopted the theories that predict human behavior and have tailored them to the IS domain to predict the usage of a particular IT or System. Within the IS literature, these ideas have taken shape in the form of various models following the conceptual framework that individuals' reaction to using a particular technology may influence their intention of actually using that technology. The dominant model, in the IT domain, is the Technology Acceptance Model (TAM) (Davis, 1989), which contends that behavioral intention to use an IS is contingent on two salient beliefs, namely perceived usefulness and ease of use. TAM has been widely applied to understand the attitude one holds about the use of technology, which is used to predict the adoption and use of IT.

While TAM has been widely used in technology acceptance studies and has provided rich empirical evidence upon individuals' acceptance of technology, the model has not been tested. There is an ongoing debate whether the parsimonious TAM is explanatory enough or whether additional factors should be included in the model to obtain a richer explanation of technology adoption and use [e.g. (Mathieson, 1991; Taylor et al., 1995; Plouffe et al., 2001; Venkatesh, 2003)]. Many researchers suggested that TAM needs to be enhanced with additional variables to provide an even stronger model (Legris et al., 2003; Kenneth et al., 2003), especially when applied in contexts that are beyond the traditional workplace [e.g., (Brown et al., 2005; Heijden, 2004)].

For example, TAM has been modified to accommodate the new properties of wireless business environments, incorporating perceived playfulness and security as antecedents of intended system use, and task type as moderator to the aforementioned relationships (Fang et al., 2006). Similarly, Hung et al. (2003) extended TAM with factors from the Theory of Planned Behaviour (Ajzen, 1991) and Innovation Diffusion Theory (Rogers, 1995) to predict WAP services adoption. Finally, Cheong and Park (2005) suggested that perceived system quality, contents quality, and Internet experience may be used as predictors of the original salient beliefs of TAM, namely perceived ease of use and usefulness. They applied and validated the proposed model to assess mobile Internet acceptance in Korea. In our case, we chose to augment the technology acceptance model with issues related to innovation adoption, privacy and switching cost features, for the reasons discussed below.

3.1 Technology acceptance model

The original TAM consisted of perceived ease of use (PEOU), perceived usefulness (PU), attitude toward using (ATU), behavioral intention to use (BI), and actual system use (AU). PU and PEOU are the two most important determinants for system use, while ATU has been omitted due to weak predictions of BI and/or AU (Venkatesh, 2000; Taylor et al., 1995; Taylor, 1995). PU is defined as the "the degree to which a person believes that using a particular system would enhance his or her job performance" and PEOU refers to "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989). Many studies examining e-commerce technology adoption through TAM provide empirical evidence that PU affects BI, while PEOU affects BI directly and indirectly through PU (e.g (Wu et al., 2005; Lu et al., 2005)).

H1a. *Perceived ease of use (**PEOU**) has a **direct positive effect** on perceived usefulness (**PU**)*
H1b. *Perceived ease of use (**PEOU**) has a **direct positive effect** on behavioral intention to use (**BI**)*
H2. *Perceived usefulness (**PU**) has a **direct positive effect** on behavioral intention to use (**BI**)*

3.2 Innovation diffusion theory

The proposed system provides an alternative approach of purchasing tickets of sports events. Current practices suggest that a ticket of an athletic event may be purchased either physically or through electronic means (irrespectively whether it is through the Internet or another medium - e.g. via phone reservation). Therefore, we considered important to include in our model factors that stem from IS theories that investigate how people adopt innovative technologies.

Diffusion of innovations is a multidisciplinary theory frequently applied in IS acceptance research. Based on a synthesis of a considerable body of adoption research, Rogers (1995) formulated a general theory to explain the adoption of various types of innovations. The theory views adoption as a process by which an innovation is communicated through certain channels over time among the members of a social system. For the adoption of an IS innovation, people do not usually have prior knowledge or experience to assist them in forming clear perception beliefs. In effect, their perceptions are formed by five innovation characteristics, namely relative advantage, complexity, compatibility, trialability, and observability (Rogers, 1995). Nevertheless, several studies that investigated the application of the research model in several domains concluded that only relative advantage, complexity, and compatibility play important roles in determining the degree an individual adopts an innovative IT (Sultan et al., 1990; Karahanna et al., 1999).

At the same time, several IS researchers have noted that the perceived usefulness and ease of use beliefs in TAM are conceptually similar to the relative advantage and complexity constructs in innovation diffusion theory (Moore et al., 1991; Taylor et al., 1995; Venkatesh et al., 1996), suggesting a similarity between the two models. Therefore, we have incorporated only the compatibility construct in our research model. Compatibility denotes the "degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters". An idea that is incompatible with the values and norms of a social system will not be adopted as rapidly as an innovation that is compatible. Researchers have posed that compatibility effects PU and BI (Wu et al., 2005).

H3a. *Compatibility **(COM)** has a **direct positive effect** on perceived usefulness **(PU)***
H3b. *Compatibility **(COM)** has a **direct positive effect** on behavioural intention to use **(BI)***

3.3 Theory of Perceived Risk

The theory of perceived risk has been applied to explain consumer behavior in decision making since the 1960s. The definition of perceived risk has changed since online transactions became popular, and has been studied in that area a lot in recent years (e.g., (Jarvenpaa et al., 2000; Featherman et al., 2003)). Today, perceived risk refers to certain types of financial, product performance, social, psychological, physical, or time risks when consumers make transactions online (Forsythe et al., 2003). Other research also indicated that perceived risk is an important determinant of consumer attitude toward online transactions (Cho, 2004).

As our system employs automated monetary transactions via the RFID smart card, we need to examine risk issues that might affect individuals' perception towards use. Moreover, RFID technology has raised many privacy fears as it is perceived that it would be used to track, identify, and acquire personal information in a malicious way (Thiesse, 2006; Angell et al., 2006). To this end, people may fear that companies will use RFID technology to profile individuals and proceed to aggressive sales and social exclusions. In order to predict the adoption of the RFID ticketing system we need to take into consideration the perceived risk that might affect negatively an individual's decision making process of adopting and using the system.

H4. *Perceived risk (**PR**) has a **direct negative effect** on behavioural intention to use (**BI**)*

3.4 Switching Barrier Theory

In the process of technological development, the adoption of a new system or service implies that individuals will eventually switch from the old to the new one system. According to Switching Barrier Theory, individuals are less likely to adopt a new system or service if they perceive a high switching cost. Jones et al. (2000) classified the perceived switching costs into three categories: economical, social, and psychological. Likewise, they classified the switching barriers into three groups: attractiveness of alternatives, interpersonal relationship, and perceived switching cost.

Interpersonal relationship refers to the strength of personal bonds that are developed between customers and their service provider (Jones et al., 2000). People are likely to remain loyal to services where this relationship is strong (Jones et al., 2000). Perceived switching cost is the degree to which an individual believes that switching a service provider would incur certain cost to him/her. This cost may refer to time, money, effort, or any other form of psychological cost associated with switching away from the service provider (Guiltinan, 1989; Jones et al., 2000; Kim et al., 2004). In our case, the service provider is the same for both services (the sport club) so we are not going to examine these two aspects of switching barrier.

Attractiveness of alternatives refers to the perceived reputation, image, and service quality of a competing alternative solution (Bendapudi et al., 1997). In our case, there are several competing approaches ranging to season tickets, phone reservations, and e-ticketing purchases. Hence, we can expect that the attractiveness of these approaches may have negative impact on the intention to accept the proposed service.

H5. *Attractiveness of alternatives (**AA**) has a **direct negative effect** on behavioural intention to use (**BI**)*

The proposed research model, incorporating all the aforementioned hypotheses, is illustrated in Figure 4.

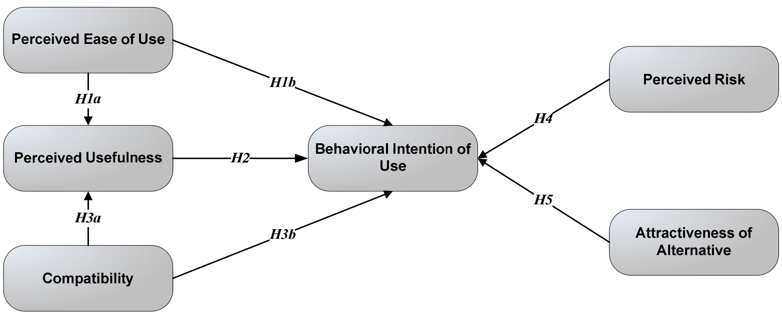

Figure 4 Proposed research model

4 RESEARCH METHOD

A lab experiment was executed to ascertain the acceptance of the proposed system. The lab experiment lasted one week and subjects were invited via email. The experiment participants were exposed to the system's functionality and were then prompted to use it following specific usage scenarios. The scenarios involved issuing of the smart card, buying tickets for specific games, and entering the stadium (virtually) by using the RFID card. Each session lasted 30 minutes. After each session, participants were asked to fill a questionnaire, which included a set of items concerning the constructs of the proposed research model. The items were drawn from relevant studies (see Table 2) and were measured following a Likert scale anchoring from 1(totally disagree) to 5(totally agree).

Table 2: Questionnaire items for each construct		
Constructs	**Reference Study**	**Number of Items**
Perceived Ease Of Use (PEOU)	(Davis, 1989)	4
Perceived Usefulness (PU)	(Davis, 1989)	4
Behavioral Intention Of Use (BI)	(Davis, 1989)	2
Compatibility (COM)	(Wu et al., 2005)	2
Attractiveness Of Alternative (AA)	(Cheong et al., 2005)	3
Perceived Risk (PR)	(Vijayasarathy, 2004)	3

Table 2 Questionnaire items for each construct

The questionnaire was divided in two parts. The first part measured the perceived acceptance of the system, while the second part collected demographic details of the participants. The sequence of measurement items was randomized in the questionnaire to ensure internal consistency (Cook et al., 1979) and construct validity (Straub et al., 2004). In overall 78 individuals took part in the lab experiment voluntarily, from which 71 questionnaires where consistent. The sample's descriptive statistics are presented in Table 3.

Table 3: Sample's descriptive statistics (N=71)					
Gender	Men	70.4%	**Education**	Elementary School	0.%
	Women	29.6%		Junior High/Middle School	19.7%
Age	<18	19.7%		High School	33.9%
	18-24	39.4%		Bachelor's degree	22.5%
	25-34	28.2%		Master's degree (MSc, MA, MBA)	23.9%
	35-50	12.7%		Doctorate Degree (Ph.D)	0. %
	>50	0. %			

Table 3 Sample's descriptive statistics (N=71)

5 RESULTS

All questionnaire responses were entered in SPSS version 13.0 for detailed statistical analysis. To demonstrate the validity of our research approach we followed closely the recommendations of Karahanna *et al.* (1999) and Straub *et al.* (2004) regarding the validation of IS positivist instrumentations. To ensure content validity, we utilised established constructs (demonstrating increased internal reliability in other, relevant, studies) from IS literature. Construct validity testing was performed to remove unreliable items from the respective constructs through the use of the Cronbach Alpha reliability test. We dropped items with Cronbach Alpha values below .60 as indicated by Straub et al. (2004). Table 4 presents the results of the construct validity tests per variable examined as well as the constructs that were removed following the suggestions of the reliability analysis test. The construct of compatibility was rejected as it did not overcome the threshold value of .60, thus the hypotheses ***H3a*** and ***H3b*** were rejected as well.

Table 4: Construct validity results				
Constructs	**Average**	**Standard Deviation**	**Cronbach Alpha**	**Rejected**
Perceived Ease Of Use (PEOU)	3.9718	.85727	.856	No
Perceived Usefulness (PU)	3.8908	.84909	.842	No
Behavioral Intention Of Use (BI)	3.9507	.96790	.930	No
Compatibility (COM)	3.3873	.91884	.580	Yes
Attractiveness Of Alternative (AA)	3.6620	.92151	.800	No
Perceived Risk (PR)	3.6995	.76252	.735	No

Table 4 Construct Validity Results

To assess the measurement model we performed linear regression analysis in two stages. The first stage considered PU as the dependent variable with PEOU being its predictor, and the second stage measured BI as the dependent variable, with PU, PEOU, PR, COM and AA being its predictors. Table 5 summarizes the results of the first stage that provide empirical evidence that hypothesis ***H1a*** is supported.

Table 5: First stage linear regression analysis (PU as the dependent variable)							
Model	**R^2**	**Adjusted R^2**	**Change in R^2**	**F**	**Sig. of F**	**Change in F**	**Sig. of change in F**
Model Summary							
1	.619	.614	.619	112.195	.000	112.195	.000
Predictors: (Constant), PEOU, Dependent Variable: PU							
Coefficients							
	Variable	**B**	**S.E. B**	**Beta**	**t**	**Sig.**	
1	(Constant)	.795	.299		2.661	.010	
	PEOU	.779	.074	.787	10.592	.000	
Dependent Variable: PU							

Table 5 First Stage Linear Regression Analysis (PU dependent variable)

Table 6 summarizes the results of the second stage that provide empirical evidence, which supports hypothesis ***H2*** and rejects hypotheses ***H1b***, ***H4***, and ***H5***. The model explains the 66.1% of the variance of BI.

Table 6: Second Stage Linear Regression Analysis (BI as the dependent variable)							
Model	**R2**	**Adjusted R2**	**Change in R2**	**F**	**Sig. of F**	**Change in F**	**Sig. of change in F**
Models Summary							
1	.636	.630	.636	120.411	.000	120.411	.000
Predictors: (Constant), PU, PR, AA, PEOU, Dependent Variable: BI							
Coefficients							
	Variable	**B**	**S.E. B**	**Beta**	**t**	**Sig.**	
1	(Constant)	.414	.330		1.257	.213	
	PU	.909	.083	.797	10.973	.000	

Excluded Variables							
	PEOU			.207	1.789	.078	
	AA			.101	1.188	.239	
	PR			.016	.142	.887	
Dependent Variable: BI							

Table 6 Second Stage Linear Regression Analysis (BI dependent variable)

6 DISCUSSION

Innovative technologies are used more and more in traditional everyday activities of our lives. These technologies formulate and support a new IS class which is commonly referred to as Pervasive Information Systems. The present study aimed at investigating whether established factors from traditional IS user acceptance theories may be employed to predict user behaviour in the Pervasive IS space. To this end, we developed an integrated model that incorporated factors stemming from heavily cited research models measuring IS acceptance and consequent use. To assess the model validity, we developed a Pervasive IS that supports access control in athletic events through RFID. We selected RFID technology because it has been gradually establishing its place in such application areas as supply chain management (Prater et al., 2005), transportation and logistics (Smith et al., 2003), and security management (Juels et al., 2003).

The results highlighted that the salient beliefs of the technology acceptance model, namely usefulness and ease of use, are the predominant factors in assessing behavioural intention towards the system's use. This is in accordance with the findings of several IS studies indicating the predominance of these factors in TAM [e.g. (King et al., 2006; Venkatesh, 2000; Legris et al., 2003)]. However, the remaining factors that were included in the model, namely perceived risk and attractiveness of alternatives, did not seem to enhance the prediction of Pervasive IS user acceptance (the compatibility factor failed the construct validity test and was excluded from the model).

We acknowledge that the application domain and the methodological approach may have influenced the results of the proposed study. Indeed, the confirmation that ease of use remains the most significant variable provides a hint that, although over the past few years individuals have been familiar with smart card technologies (e.g. in the form of Automatic Teller Machines), the task of issuing, purchasing, and using RFID tickets to grant access in athletic events, may not be as intuitive or free of effort. Poorly designed interfaces, bad physical placement of technical infrastructure, obscure usage guidelines, and complex payment and checkout procedures, may all contribute to increased consumer frustration when using RFID ticketing systems. Therefore, to attract and keep customers, it is imperative to design the system architecture in such a way that enhances overall usability.

One of the major inhibitors of on-line shopping has been the perception of poor security associated with payment methods. Indeed, it has been reported that on-line shoppers are still suspicious about transmitting credit card information over the Internet (Friedman et al., 2000). However, in RFID ticketing systems, the perceived risk of the transaction does not seem to significantly concern users. One explanation is that the data contained in the RFID card are not critical because they do not lead to disclosure of personal information, and they cannot be abused for monetary purposes (the RFID card contains an encrypted identification number, which is crosschecked each time the card is used with a server's database). Moreover, users physically participate in all interactions with the system, thus further increasing their feeling of security. Finally as a PIN code is expected from users by the system for each task they perform security concerns are even further alleviated. Consequently, stakeholders aspiring to invest on such solutions need to develop the necessary security schemes and safeguards and inform users about how their personal information will be manipulated.

The fact that factors stemming from the switching barrier theory and diffusion of innovation theory did not statistically affect the measurement model implies that users are still accustomed with the traditional means of purchasing tickets and did not perceive the benefits of the proposed system compared to existing practices. This can be attributed to the lab experimental setting, since participants were not exposed to a fully working prototype in real-life conditions. In effect, previous studies investigating user acceptance of emerging Information Technologies support our argument that such or similar factors should be included in the measurement model. For example, Lu et al. (2005) revealed that trust (similar to perceived risk in this study) is a predictor of intention of use in their study assessing perceived acceptance of wireless internet through mobile devices. Likewise, in the study of Wu et al. (2005), it was suggested that compatibility significantly affects the intention of using mobile health care services. Therefore, we suggest that future studies consider the proposed model in its entirety through field testing or longitudinal analyses to validate the conclusion reached in this study. Furthermore, perceived risk is advisable to be better appointed in order to explore privacy and security fears beyond transaction-oriented risk, as presented in this study.

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