Please cite as: Liébana-Cabanillas, F., Molinillo, S., & Ruiz-Montañez, M. (2019). To use or not to use, that is the question. Analysis of the determining factors for using NFC Mobile Payment Systems in Public Transportation. *Technological Forecasting & Social Change*, 139, 266-276.

To use or not to use, that is the question. Analysis of the determining factors for using NFC Mobile Payment Systems in Public Transportation

Abstract:
There is growing interest in our society in making payments using mobile phones as an alternative to cash, checks or credit cards. The objective of this study is to analyze the status of Near Field Communication (NFC) mobile payment systems in public transportation, as well as the factors that affect users' intentions to continue using said systems. To meet this objective, a personal survey was conducted with a sample of 180 users with experience of using this type of system. A comprehensive review of the scientific literature justifies the development of a behavioral model that explains the continuance intention of NFC mobile payments through a structural equation model. The results show that satisfaction, service quality, effort expectancy and perceived risk are determining factors of the continuance intention to use this technology. Finally, the managerial conclusions and implications offer the companies that manage these public services new business opportunities based on user behaviors.

Keywords: mobile payment; NFC; Structural Equation Model; continuance intention.

1. Introduction

The rapid adoption of mobile phones in society and their role in the development of personal and professional activities has been one of the most important technological events in recent decades (Masamila et al., 2010). According to the GSMA (2018) report, "The Mobile Economy", the number of unique users of mobile services in 2017 exceeded 5 billion people globally, which represents a penetration rate of 66%, with extreme values in geographical areas such as Europe (85%), North America (84%) and Sub-Saharan Africa (44%). According to Ricci (2011) and Egger (2013), mobile phones are becoming a primary platform for access to information and a primary area for mobile applications.

In light of this trend, most technology companies are focusing their efforts on increasing the number of available mobile services, including mobile payments (Liébana-Cabanillas, 2012), which are defined as all commercial transactions that take place over networks and wireless devices (Hu et al., 2008).

Near Field Communication (NFC) is one of the primary technologies used for certain mobile payment systems. NFC consists of two elements: the initiator, which starts and controls communication and information exchange, and the target, which responds to requests. This technology can operate regardless of whether the terminal is on or off, improving functionality (Kumar, 2011) by relaying information to a customer's bank via chip, cell phone SIM card or even a memory card.

Advantages of NFC include (Ruijun et al., 2010): (1) it can be implemented in all existing mobile terminals; (2) its wide range of uses (paying bills, making car payments, leisure activities, etc.); (3) ease of use; (4) security; (5) added value services; (6) supported on devices equipped with contactless structures; (7) it can be used as a platform to receive cash, make payments and pay for transportation worldwide and (8) users don't have to pay licensing fees.

Due to its multiple advantages, public transportation operators (i.e. bus, subway, train, etc.) have begun to adopt NFC technology in recent years for ticket purchasing and access to vehicles, especially using smartcards and mobile phones (Finžgar & Trebar, 2011). In contrast to smartcards, mobile payments do not require users to go to points of sale to buy credit before buying a ticket. Furthermore, the adoption of NFC technology for mobile payments can provide numerous additional benefits for passengers (e.g. convenience, usefulness, etc.) as well as transportation companies (e.g. faster boarding times, reduced sales' costs, environmental benefits, interaction with passengers, etc.) (Ferreira et al., 2014; Gautam et al., 2014). These benefits have led a significant number of transportation operators in various parts of the world to adopt NFC mobile payments (e.g. Boston, Dubai, Frankfurt, Hong Kong, Moscow, New Jersey, etc.) (Global Mass Transit Report, 2014).

Nevertheless, despite the potential future importance of this technology for millions of users and thousands of companies around the world, few studies have analyzed the factors affecting continuance intention. Prior research on the use of mobile phones for making payments has focused on sectors such as the hospitality industry (Ozturk & Ozturk, 2016), social networks (Liébana-Cabanillas et al., 2014c) and mobile banking (Hu et al., 2008), among others. To date, most of the studies conducted on the transportation sector have focused on the intention to use, but few have analyzed continuance intention. Continuance

intention is important because, by including this concept in behavioral research, we are no longer limited to first-time use, but can also evaluate continued use over time, assessing future behaviors derived from said use, such as loyalty, etc. (Lin, 2012).

Our research therefore has a dual objective: (1) firstly, to analyze the status of mobile payment methods in the public transportation sector and (2) secondly, to determine the factors affecting the continuance intention of users of NFC mobile payment systems when using public transport. The results are based on data collected from a personal survey given to a random sample of users of the Malaga Transportation Company (EMT-Empresa Malagueña de Transporte) in Spain. This paper is structured as follows: Section 2 introduces the literature review of similar studies on mobile payments; Section 3 outlines the proposed hypotheses and research model; Section 4 details the methodology used in this study; Section 5 presents the data analysis and research results; Section 6 includes a discussion of the implications of the results; and finally, Section 7 explains the study's main limitations and potential steps for further research.

2. Theoretical background and research model

2.1. User adoption of mobile payment

As a relatively new service, mobile payment has not been widely adopted among users. Researchers have been concerned with mobile payment user behavior and tried to identify the factors affecting users' adoption of mobile payment (Zhou, 2013). Most recent studies have focused on the adoption of mobile payment systems and reviewing classic variables (see Table 1), but few have analyzed the continuance intention of mobile payments.

Based on the literature review, the prior research of the authors of this study, and professional experience managing public transportation companies, a model was defined to validate the research hypotheses discussed in the following sections.

Table 1. Evaluating research on NFC mobile payment systems

Authors	Dependent Variable	Independent Variables
Pham and Ho (2015)	Intention to use	Perceived ease of use, compatibility, perceived risk, trialability, perceived cost, additional values of NFC mobile payments, innovativeness in new technologies, absorptive capacity, trust and attractiveness of alternatives.
Kaitawarn (2015)	Intention to use	Personal factors, performance expectancy, effort expectancy, social influence, facilitating condition, attitude, switching cost, convenience and privacy.
Ramos-de-Luna et al. (2015)	Intention to use	Perceived compatibility, perceived usefulness, perceived security, attitude towards using, intention to use, subjective norms, perceived ease of use, personal innovation in IT and individual mobility.
Slade et al. (2015)	Intention to use	Performance expectancy, effort expectancy, social influence, facilitating conditions,

Authors	Dependent Variable	Independent Variables
		habit, price value, hedonic motivation, perceived risk and trust in provider.
Jenkins and Ophoff (2016)	Intention to use	Security concerns, privacy concerns, trust concerns, perceived risk, perceived value, social influence, perceived ease of use and perceived financial resources.
Morosan and DeFranco (2016)	Intention to use	Performance expectancy, effort expectancy, hedonic motivation, privacy concerns, regulatory focus, promotion and prevention.
Liébana-Cabanillas et al. (2016a)	Intention to use	Subjective norms, perceived ease of use, perceived usefulness, attitude to use and perceived security.
Liu and Yi (2017)	Intention to use	Social influence, devices compatibility, lifestyle compatibility, relative advantage, use context and perceived risk
Khalilzadeh et al. (2017)	Intention to use	Facilitating condition, self-efficacy, attitude, security, trust, utilitarian performance expectancy, effort expectancy, social influence, hedonic performance expectancy and risk.
Shen et al. (2017)	Intention to use	Trust in remote m-payment, initial trust, perceived compatibility, relative advantage, use contexts and perceived risk.
Liébana-Cabanillas et al. (2017)	Intention to use	Perceived usefulness, perceived ease of use, trust, mobility, customization, and customer involvement.
Lu et al. (2016)	Continuance Intention	Social influence, privacy, mobility, privacy protection, mobility, usefulness and satisfaction.
Chen and Li (2017)	Continuance Intention	Post perceived usefulness, disconfirmation of pre-perceived usefulness, post perceived risk, disconfirmation of pre-perceived risk, trust and satisfaction..

2.2. Mobile payments in public transportation

Public transportation development is currently a priority for many public administrations and governments and is clearly a cornerstone of sustainable development in cities (Banister, 2008). Through different approaches and projects, government authorities hope to make public transportation more accessible to citizens, reinforcing quality, comfort and reliability, among other aspects. Along these lines, public transportation companies have recently begun improving services by applying elements that are widely used in our society, such as mobile phones and associated supported functions, such as NFC payment. The NFC system is the most widely used among different types of mobile payments. Precisely, one of the secrets of its success is the investment major companies are currently making in this technology, including Apple Pay, Samsung Pay, Vodafone Wallet, BBVA Wallet, and Android Pay, among others.

The adoption of NFC technology for mobile payments offers numerous advantages for passengers as well as transportation operators (Ferreira et al., 2014; Gautam et al., 2014). The NFC Forum (2011) highlights the following advantages of NFC mobile payments: (A) for passengers: (i) greater convenience and ease of access, (ii) operators can offer better value fare pricing, (iii) better protection for passenger fare tokens, (iv) it works better in adverse conditions, (v) supports secure data updating for more accurate fares, (vi) allows for multi-application cards, and (viii) offers the option of personalized individual cards with automatic credit refill features, among others; (B) for operators: (i) better revenue protection from fraud, (ii) lower cost of maintenance, (iii) facilitates faster boarding, (iv) allows for new fare business models, (v) makes remote maintenance possible, (vi) allows for cross-border fares and interoperable travel, and finally, (vii) supports convergence with complementary applications and technologies.

Extensive research has been conducted over a long period of time on the techno-social acceptability issues of new technology and technology-based products and services (Hsiao et al., 2016; Upadhyay & Jahanyan, 2016). For example, in regard to mobile phones, the adoption of online games (Merhi, 2016), social media (Zolkepli & Kamarulzaman, 2015), and mobile TV services (Borges et al., 2015) among others, but also in terms of new mobile payment systems (Dennehy & Sammon, 2015; Gao & Waechter, 2017; Ramos-de Luna et al., 2015). However, very few studies on mobile payment systems have been applied to the public transportation sector.

The concept of mobile ticketing systems applied to the public transportation sector can be defined as using mobile devices, such as smartphones or tablets, to purchase and validate travel tickets (Ferreira & Dias, 2015). Four lines of research have been identified in the literature on this subject: (1) some authors have holistically analyzed the NFC mobile ticketing business model in order to identify critical issues that affect the commercial success of these services (Juntunen et al., 2010); (2) others have focused on the development and implementation of smart phone applications that are more effective and simpler than the current ticketing system (Ghosal et al., 2015); (3) other authors have analyzed the problems with mobile ticketing systems where proximity technologies are used for validation and checking e-tickets, thereby eliminating the ticket purchase stage, which can either be done remotely or in proximity (Ceipidor et al., 2013); and (4) in terms of security and privacy, as well as uncertainties in the related value networks and business models (Juntunen et al., 2012).

The scarce amount of existing literature on NFC mobile ticketing in public transportation focuses on analyzing specific experiences in different countries. Ferreira et al. (2014) analyze the NFC payment system for public transportation in the city of Porto (Portugal). This study revealed that users considered the system to be extremely useful, since it is more convenient than traditional systems and improves the travel process and experience. They also felt safe paying with their mobile phones and valued the fact they could access information about their trips, tickets and accounts. The ticket validation process turned out to be one of the main challenges that should be addressed by public transportation payment systems, as compared to the simplicity of traditional systems. Leal (2015) provides a comparison and analysis of the use and costs of different technologies (i.e. NFC, QR Codes, Bluetooth and Location data) for the validation process of public transportation tickets in Porto (Portugal). Costa et al. (2016) propose an integrated analysis of the services offered to travelers via mobile phones, including mobile payment as an element that allows for the improvement of services on the platform under analysis.

Based on the Technology Acceptance Model (TAM), the Diffusion of Innovation Model (DOI) and the Unified Theory of Acceptance and Use of Technology (UTAUT) model, Di Pietro et al. (2015) propose a new model they call the Model of Mobile Payment Acceptance (IMMPA), which integrates security and compatibility along with the other classic variables.

2.2. The EMT's NFC Mobile Ticket

The Malaga Transportation Company (EMT) is the municipal company in charge of the urban public transportation system in the city of Malaga (Spain). It currently manages a fleet of 255 buses that provide service for approximately 44 million passengers per year. In 2015, the company launched the mobile application "EMT Malaga NFC" so that users could pay for the bus with their mobile phones just as they would with contactless cards. By the end of 2015, the number of users had reached 1,310. That first year the system only worked with one telephone operator (Orange). The following year, use of the system was expanded to include two more telephone operators (Movistar and Vodafone) and the number of users increased to 4,016. The number of credit refills was 719 in 2015 and 4,702 in 2016. The average number of trips purchased by mobile per year was 17,067 units.

The application's operation is very simple: users can purchase new trips on their mobile devices anytime and anywhere, which will be automatically transferred to their smartphones without having to visit any point of sale or locations where credit can be added to their phones. When boarding the bus, users simply have to pass their mobile phones in front of the validation machine. They can also instantly find out how much travel credit is left, when it was last used, when credit was last added, the current expiration date for their transportation I.D. card, and the history of their most recent uses. To access this service, users must: (i) check to make sure their phones have NFC technology; (ii) download the EMT application from the Apple Store or Google Play; (iii) have a data plan contract for internet access with their telephone operator, and (iv) have a credit or debit banking card where the credits can be charged. These operations are described in Figure 1.

Figure 1. The Malaga EMT's NFC mobile ticket operations

3. Conceptual framework and development of hypotheses

This study identifies specific valuable components within the context of mobile payments and the intention to continue using NFC payment systems.

3.1. Convenience

In the current marketing landscape, time-poor consumers look favorably on firms that offer added value by improving convenience in the search for, access to, and purchase and use of services (Roy et al., 2016). Nowadays, people believe in technology only if it makes their lives easier (Limantara et al., 2013). Mobile ticketing has several advantages when compared to traditional ticketing systems, such as providing passengers remote and ubiquitous access to payment services, eliminating the need to wait in lines, simplicity, and availability (Mallat, 2007). Convenience is actually a combination of time utility and place utility that can have an impact on the user's decision to use a particular system (Pal et al., 2015) and the resulting satisfaction of using said system. Therefore, the convenience of use will have a positive effect on the satisfaction of consumers using the technology (Lim & Kim, 2011; Seiders et al., 2005; Seiders et al., 2007). Consequently, we propose the following hypothesis:

H1: Convenience has a positive effect on the effort expectancy of using NFC payment systems for public transportation.

3.2. Social Value

Social value refers to the perceived usefulness of an individual's connection with one or more specific social groups (Sheth et al., 1991), as well as the acceptability or usefulness in terms of an individual's relationships with his or her social environment (Fandos Roig et al., 2006). Within the context of mobile technology, it is clear that the application of mobile systems is considered to be an increasingly useful modern product or service (Chang, 2015), which consequently improves users' satisfaction with its use. Various studies support the relationship between service value and satisfaction (Hu et al., 2015; Kettinger & Smith, 2009; Kim & Son, 2009). More specifically, in the mobile environment, social value refers to the usefulness of mobile applications derived from their perceived ability to enhance social well-being (Chang, 2015; Wang et al., 2013), which leads us to the following hypothesis:

H2: Social Value has a positive effect on the satisfaction of users of NFC payment systems in public transportation.

3.3. Service Quality

The concept of perceived quality was defined by Zeithaml (1988) as the consumer or user's judgment of a product's superiority or excellence. Later, Gefen (2000) defined it as the subjective comparison consumers make between the quality of the service they want to receive and what they actually get. In our case, it will be defined by their perception of quality based on the new payment tool and its functions (Kumar & Lim, 2008). Various researchers have studied service quality under the confirmatory paradigm; that is, an assessment of the perceived service quality based on the existing differences between expectations and achieved results (Fransi, 2002). Nevertheless, in accordance with Grönroos (1994), for this study, perceived quality is considered to be the result of a continuous assessment of the experience using the mobile payment tool. Consequently, the perceived quality measured in this study is a general quality of the analyzed mobile

payment system. Based on these approaches, we propose a relationship between quality of service and perceived trust, satisfaction, continuance intention and effort expectancy.

Firstly, in online services, quality reflects aspects such as the response speed of the system, reliability, reduction of uncertainty, ease of use, adaptation to the users' needs and the fulfillment of their expectations, among other things (Ahn et al., 2007). Quality service communicates to the user the provider's ability to comply with the requirements of service provision, which fosters their trust. On the contrary, when a system has a poor interface design, is slow, responds irregularly and does not adequately guarantee service provision, users' confidence is reduced (Gao & Waechter, 2017). Service quality has been confirmed to significantly improve users' trust in mobile systems, as it reduces risk in terms of errors, complexity, etc. (Almarashdeh, 2018; Mohd Suki, 2011), particularly in mobile payment services (Zhou, 2013). Therefore, we propose the following hypothesis:

H3: Service Quality has a positive effect on the perceived trust of users of NFC payment systems for public transportation.

Secondly, various authors have highlighted the importance of user satisfaction in the use of information systems. Satisfaction can be understood as a result of the system performance evaluation process (Kuo et al., 2009). Perceived service quality is closely linked to satisfaction, since it reflects the user's overall impression of the provider's effectiveness in providing the service (Deng et al., 2010). Several empirical studies have confirmed that higher levels of mobile service quality will result in higher degrees of customer satisfaction, for example, with global mobile phone services (Shin & Kim, 2008), mobile value-added services (Kuo et al., 2009), mobile instant messaging (Deng et al., 2010) and mobile payment services (Zhou, 2013). Therefore, the following hypothesis is proposed:

H4: Service Quality has a positive effect on the satisfaction of users of NFC payment systems for public transportation.

Thirdly, service quality also drives users' continuance intention (Wang, 2015). After the adoption or use of an information system the user forms an overall perception of its quality. The higher the perceived quality, the greater will the probability that the user will continue to use the system (Hu et al., 2009). Several studies have shown that a high level of service quality enhances users' continuance intentions due to their positive predisposition toward the system (Abbas & Hamdy, 2015; Hsu et al., 2014). Service quality contributes positively to the user's evaluation of the system and, therefore, motivates him/her to continue using it (Wang, 2015). Therefore, we propose the following hypothesis:

H5: Service Quality has a positive effect on the continuance intention of users of NFC payment systems for public transportation.

Finally, service quality improves effort expectancy by facilitating the use of the technology. High quality service normally includes features such as a user guide or demonstrator, user support, a clear and intuitive interface, training tools and other options that make the user feel that the technology is easy to use (Wang & Lin, 2012). Empirical studies have shown that where the service quality of an information system is high, that

the user will have to spend less time and effort to learn how to use it (Ahn et al., 2007, Almaiah et al., 2016, Motaghian et al., 2013; Wang & Lin, 2012). These findings consequently lead to the following hypothesis:

H6: Service Quality has a positive effect on the effort expectancy of users of NFC payment systems for public transportation.

3.4. Perceived Trust

In recent decades, marketing studies have highlighted the importance of trust among parties as a tool that favors the continuity of a relationship, which is a very important aspect in the business world (García-Rodríguez et al., 2008). Trust in online markets implies the belief that a company will fulfill their commitments without taking advantage of the buyer (Wu & Chen, 2005). Therefore, trust and satisfaction are two strongly related constructs that have been examined in numerous studies. A user's trust in a service determines their level of satisfaction, whether in an offline (Lin &Wang, 2006) or online context (Chiou, 2004). Recent studies have demonstrated that the trust derived from information systems, mobile websites, etc. has a significant positive influence on the relationship between consumers' trust and their level of satisfaction (Liébana-Cabanillas et al., 2016b; Zhou, 2011a). Accordingly, the following hypothesis has been formulated:

H7: Perceived Trust has a positive effect on the satisfaction of users of NFC payment systems for public transportation.

3.5. Effort Expectancy

Effort expectancy is described as the degree of ease associated with consumers' use of technology (Venkatesh et al., 2012). Some authors identify effort expectancy with the variable perceived ease of use as defined by Davis (1989) (Di Pietro et al., 2015); consequently, many of the relationships proposed in various studies have obtained similar results (Pynoo et al., 2011). Nowadays, many mobile devices offer various services that improve the users' ability to use them and, consequently, their continuance intention (Chiu et al., 2010). We therefore propose the following hypothesis:

H8: Effort expectancy has a positive effect on the satisfaction of using NFC payment systems for public transportation.

3.6. Satisfaction

Consumer satisfaction is especially important during the assessment phase of their experience when buying, consuming, or using a product or service, and will consequently be vital to the consumer's long-term responses favoring continuance intention and loyalty, where applicable (Grönroos, 1991). Previous studies have drawn on information systems theories such as the technology acceptance model and innovation diffusion theory to examine users' adoption of mobile payments (Liébana-Cabanillas et al., 2014a), but few studies examine the post-adoption usage of mobile payments (Yuan et al., 2016; Zhou, 2014). Satisfaction predicts an individual's continuance intention, which is defined as the degree to which a user intends to continue using an information system (Hsu & Lin, 2015) or, in this case, the payment system in question (Shang & Wu, 2017; Zhou, 2011b). Therefore, based on prior research, we propose the following hypothesis:

H9: Satisfaction has a positive effect on the continuance intention of users of NFC payment systems for public transportation.

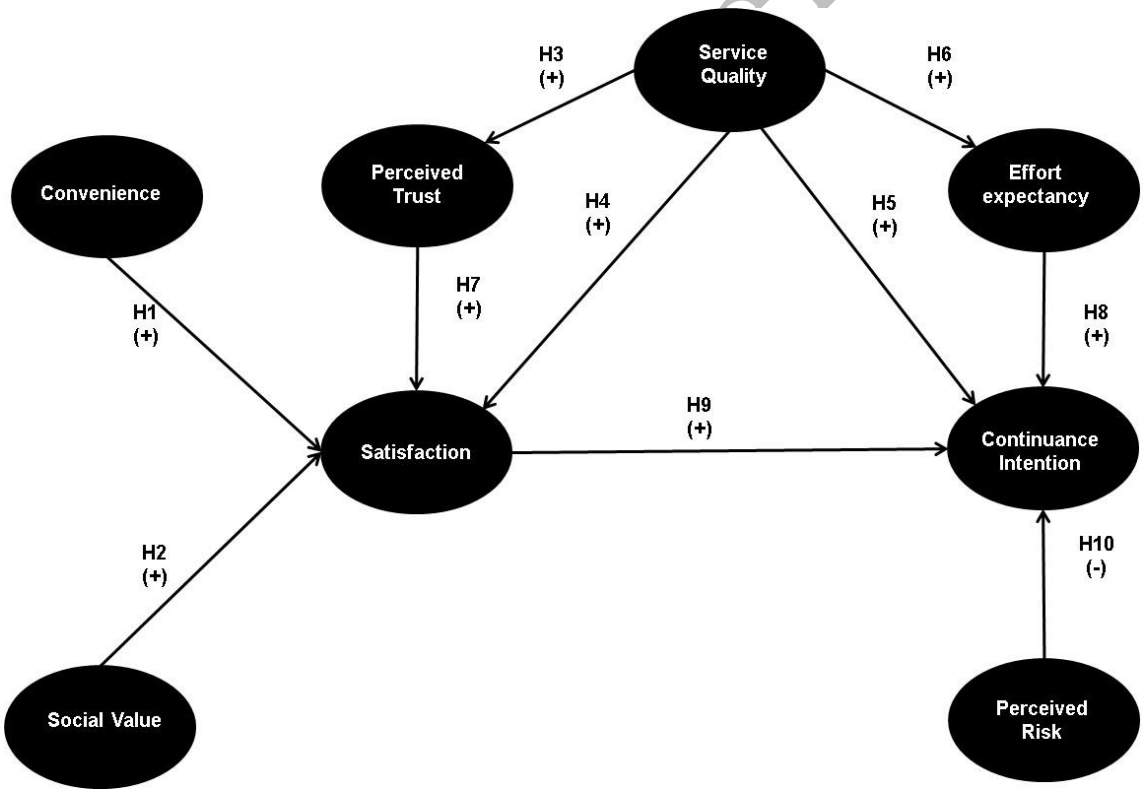
3.7. Perceived Risk.

Bauer (1960) analyzes perceived risk based on two components: uncertainty (consumers' lack of knowledge regarding what might happen when they make a purchase) and the eventual negative consequences of the purchase. Subsequently, the same author stated that all consumer behavior entails risk, since the consequences derived from said behavior cannot be anticipated with certainty (Bauer, 1967). Perceived risk is one of the important components of various adoption models for information systems. It reflects users' perceptions of the uncertainty and adverse consequences of engaging in an activity, reducing the intention to use and, consequently, the continuance intention (Cheng & Huang, 2013; Yuan et al., 2016). We therefore propose the following hypothesis:

H10: Perceived Risk has a negative effect on continuance intention of users of NFC payment systems for public transportation.

Figure 2 summarizes all of the hypotheses in the final proposed model.

Figure 2. Conceptual Model



4. Research methodology

4.1. Measurement development

In order to meet the objectives of this study, a personal survey was conducted. The survey questionnaire is organized in three sections. The first section includes various assessment questions to confirm the subject's interest and consistency. The second section groups the items in order organize the proposed study. The third section contains the users'

sociodemographic information and other information in order to analyze the participants' profiles, classification and the relevant variables.

The data was collected in three phases: In the first phase, a group of academic experts and professionals from the Malaga transportation sector conducted a qualitative review of the survey questions during various work meetings. In the second phase, an initial validation of the research questions was performed on a sample of the study's target population. This design was focused on the questionnaire's assessment and validation in order to determine the acceptance level, dimensionality, reliability, and validity of the proposed scales. Finally, after verifying the aforementioned results, the final validation of the questionnaire was conducted on the sample selected for this purpose.

Table 2 shows the items for this study and the supporting literature for each construct. It shows that four items are used to measure the convenience of NFC payment systems (Pal et al., 2015). Three measurement items are used to analyze effort expectancy (Hew et al., 2015; Venkatesh et al., 2012), satisfaction (Hsiao et al., 2016; Vila & Küster, 2011), perceived risk (Liébana-Cabanillas et al., 2014b) and continuance intention (Bhattacherjee, 2001; Hsiao et al., 2016). There are four measurement items for perceived trust (Zarmpou et al., 2012) and social value (Chang, 2015; Sweene & Soutar, 2001). Finally, service quality (Ahn et al., 2007) consists of five measurement items.

Table 2. Constructs and measurement items

Convenience (Pal et al., 2015)
The NFC service is convenient because I can use it anytime (CON1)
The NFC service is convenient because I can use it in any situation (CON2)
The NFC service is convenient because it is easy to use (CON3)
The NFC service is convenient because it can be used in any location (CON4)
Effort Expectancy (Hew et al., 2015; Venkatesh et al., 2012)
I find NFC easy to use (EE1)
It is easy for me to learn how to use NFC (EE2)
Using NFC is easy for me (EE3)
Trust (Zarmpou et al., 2012)
I think that it is safe to use NFC to pay for bus tickets (TR1)
I think that my personal data is safe while using NFC (TR2)
I think that the terms of use are strictly followed (TR3)
I think that the EMT's use of NFC is trustworthy (TR4)
Service Quality (Ahn et al., 2007)
NFC Mobile Ticketing anticipates and responds promptly to my needs as a user (SQ1)
NFC Mobile Ticketing meets my expectations (SQ2)
NFC Mobile Ticketing instills confidence in users, reducing uncertainty (SQ3)
NFC Mobile Ticketing understands and adapts to users' specific needs (SQ4)
NFC Mobile Ticketing provides service monitoring for users (SQ5)
Social Value (Chang, 2015; Sweene & Soutar, 2001)
The use of NFC helps me feel accepted (SV1)
The use of NFC improves the way I am perceived by others (SV2)
The fact that I use NFC leaves a good impression on my acquaintances (SV3)
The use of NFC contributes to my social approval (SV4)

Satisfaction (Hsiao et al., 2016; Vila & Küster, 2011)
I think I made the correct decision to use this app (SAT1)
My experience using this app has been satisfactory (SAT2)
I am satisfied with the app I have downloaded (SAT3)
Perceived Risk (Liébana-Cabanillas et al., 2014a)
Using NFC systems makes me anxious (PR1)
If you start using an NFC system, there is a possibility that you might waste time using it (PR2)
The use of NFC systems may involve a possible waste of time associated with activation and learning how to use it (PR3)
Continuance Intention (Bhattacherjee, 2001; Hsiao et al., 2016)
I intend to continue using this app in the future (CI1)
I will try to use this app in my daily life (CI2)
I will continue to use this app as regularly as I do now (CI3)

4.2. Data collection and sample

The data was collected for this study through a personal survey conducted by the EMT's professional survey-takers at bus stops in Malaga in December of 2016. The individuals were selected from users of Malaga's public transportation system who have experience using NFC mobile payment services. The respondents were approached by the interviewers, using random number tables, while they were waiting at bus stops in Malaga. A total of 180 people took this survey after receiving a brief explanation of the study objectives.

4.3. Data analysis

The partial least squares (PLS) regression method was used to analyze the data in a structural equation model (SEM), as this technique is more appropriate for exploratory research and studies with small sample sizes (Fornell & Bookstein, 1982). Moreover, PLS algorithm shows greater convergence in its simplicity, offering fewer restrictions on data normality (Chin et al., 2003). The sample size in this study exceeds the minimum value of ten times the largest number of inner model paths directed at a particular construct in the inner model (Barclay et al., 1995).

SmartPLS3 software was used to analyze the data (Ringle et al., 2015). The stability of the estimates was tested via a bootstrap re-sampling procedure (500 sub-samples) (Roldán & Sánchez-Franco, 2012). A PLS model is analyzed in two stages: first, by assessing the reliability and validity of the measurement model, and second, by assessing the structural model (Anderson & Gerbing, 1988).

In order to evaluate the measurement model, it is necessary to estimate: (i) the measurement instruments' precision in providing figures free of random errors (reliability of items and variables); and (ii) the extent to which the figures obtained with the scale reflect the true differences between the objects and the features being measured (convergent and discriminant validation).

The individual reliability of each item is evaluated by examining the simple correlations between the indicators and their respective variables. Values over 0.7 imply that the

shared variance between the construct and its indicators is greater than the error variance (Barclay et al., 1995).

The variable's reliability allows us to evaluate the accuracy of the items by measuring the same latent variable (internal consistency), using Cronbach's alpha coefficient (Cronbach, 1951) and the factor's composite reliability (CR) (Nunnally & Bernstein, 1994). The minimum recommended values in the literature is 0.7. The average variance extracted (AVE) is used to evaluate the convergent validity (Fornell & Larcker, 1981). The AVE allows us to estimate the quantity variance a construct obtains from its indicators in relation to the quantity variance due to measurement error. The minimum recommended value is 0.5.

The discriminant validity of PLS is evaluated using three different methods: (i) the examination of cross-loadings of the indicators, according to Hair et al. (2014), requires that the loadings of each indicator on its construct are higher than the cross-loadings on other constructs; (ii) the Fornell-Larcker criterion, which analyzes whether the correlations between the dimensions are lower than the square root of the AVE (Fornell & Larcker, 1981); (iii) the heterotrait-monotrait (HTMT) ratio of correlations between two constructs should be below 0.9 (Henseler et al., 2015).

Bootstrapping was applied with 500 samples in order to achieve statistical inference. The evaluation of the structural model follows all common requirements. First, we analyzed the R^2 of each of the analyzed constructs, which indicate the construct's quantity variance explained by the model. Falk and Miller (1992) state that the appropriate value should be greater than or equal to 0.1. We then proceeded to study the standardized regression path weights that should show the relative path weight of the factors in the endogenous variables. Chin (1998) recommends values greater than 0.3, however, values greater than 0.2 may be accepted. In addition, the size of the effect (f^2) measures whether an independent latent variable has a substantial effect on a dependent latent variable. Values of f^2 from 0.02 – 0.15, 0.15 – 0.35, and 0.35 or greater indicate that an exogenous latent variable has a small, medium, and large impact, respectively (Chin, 1998). Lastly, the value of the standardized root mean square residual (SRMR) (Henseler et al., 2015) allows us to compare the difference between the observed correlation and the predicted correlation as an adjustment measurement for the model. Values under 0.08 are considered to be acceptable.

5. Results

5.1. Sample characteristics

Table 3 shows the participants' demographic characteristics. Among the respondents, 53% were men and 47% were women; 25% were between the ages of 25 and 34, and the predominant level of studies was university (29%). In terms of their principal occupation, 47% of the interviewees had full time jobs and 17% part time jobs.

Table 3. Demographic profiles of respondents

Variable	Frequency	Percentage
Sex		
Male	95	53%
Female	85	47%

Variable	Frequency	Percentage
Age		
14 – 17	10	6%
18 – 24	35	19%
25 – 34	45	25%
35 – 44	41	23%
45 – 54	25	14%
55 – 65	12	7%
Over 65	12	7%
Level of Studies		
No studies	0	0%
Elementary School Studies	23	13%
High School Studies (High School Diploma, Vocational Education, Training Modules, etc.)	53	29%
Undergraduate University Studies (diploma, degree, engineering, etc.)	53	29%
Graduate University Studies (Master, PhD)	38	21%
Other	13	7%
Income Level		
No income	10	6%
Under 650 €	11	6%
651 – 900 €	16	9%
901 – 1,200 €	23	13%
1,201 – 1,500 €	20	11%
1,501 – 1,800 €	17	9%
1,801 – 2,400 €	29	16%
2,401 – 3,000 €	21	12%
3,001 – 6,000 €	21	12%
Over 6,000 €	12	7%
Occupation		
Full-time job	85	47%
Part-time job	31	17%
Studies and works part-time	3	2%
Student	21	12%
Unemployed	12	7%
Retired or pre-retirement	18	10%
Household work	6	3%
Other	4	2%

5.2. Measurement model

First, we analyzed the descriptive statistics of the measurement instruments (Table 4). The average rating of the users was higher for the Convenience scale items, followed by Continuance Intention and Satisfaction. In contrast, the items that obtained the lowest average scores were those of the Perceived Trust scale. With respect to the standard deviation, the highest values were recorded in the Perceived Risk scale, while the lowest

values were those of the Convenience scale. In general, the mean score of the items was between 2.994 (PR3) and 6.361 (CON2), and the standard deviations were between 1.219 (CON2) and 2.385 (PR2).

Table 4 shows also that variable reliability and internal consistency are adequate since the values of the composite reliability index (CR) are between 0.836 and 0.959, while those of the Cronbach's alpha coefficient are between 0.711 and 0.944, thus exceeding in all cases the recommended threshold value of 0.7 (Nunnally & Bernstein, 1994). As regards convergent validity, Table 4 shows that the factorial loads (λ) of the items are between 0.724 (SQ4) and 0.940 (SV4), thus exceeding the minimum recommended values in the literature (0.7). In addition, the average variance extracted (AVE) reached values between 0.632 (Effort Expectancy) and 0.854 (Social Value), thus exceeding the suggested minimum of 0.5 for all constructs (Fornell & Larcker, 1981).

Table 4. Descriptive statistics, Composite reliability (CR), Average Variance Extracted (AVE) and cross loads.

Construct	Item	Mean	S.D.	λ	Cronbach's alpha	CR	**AVE**
Convenience	CON1	6.278	1.234	0.788	0.819	0.873	0.633
	CON2	6.361	1.219	0.752			
	CON3	6.039	1.372	0.828			
	CON4	6.183	1.404	0.812			
Effort Expectancy	EE1	5.656	2.199	0.729	0.711	0.836	0.632
	EE2	5.589	2.144	0.739			
	EE3	6.050	1.492	0.905			
Perceived Trust	TR1	6.167	1.340	0.754	0.824	0.882	0.652
	TR2	5.789	1.414	0.790			
	TR3	5.811	1.429	0.840			
	TR4	5.844	1.559	0.842			
Service Quality	SQ1	5.956	1.527	0.804	0.866	0.904	0.653
	SQ2	5.872	1.609	0.881			
	SQ3	5.544	1.694	0.817			
	SQ4	5.844	1.501	0.724			
	SQ5	5.772	1.608	0.806			
Social Value	SV1	4.733	2.162	0.908	0.944	0.959	0.854
	SV2	4.556	2.234	0.919			
	SV3	4.567	2.216	0.930			
	SV4	4.222	2.284	0.940			
Satisfaction	SAT1	6.100	1.557	0.812	0.870	0.920	0.794
	SAT2	5.572	1.789	0.841			
	SAT3	5.811	1.779	0.904			
Perceived Risk	PR1	3.744	2.219	0.799	0.798	0.882	0.713
	PR2	3.967	2.385	0.898			
	PR3	2.994	2.136	0.834			
Continuance Intention	CI1	6.089	1.547	0.913	0.812	0.889	0.728
	CI2	5.756	1.544	0.874			
	CI3	6.206	1.361	0.886			

Finally, the results confirm the discriminant validity of the measurement model according to the three criteria applied. First, both the constructs and the items within each construct showed higher correlations between themselves than with the others. Second, Table 5 shows that the correlations between the constructs (below the main diagonal) were lower than the root of the AVE (in bold) (Fornell & Larcker, 1981). Third, Table 5 also shows that the HTMT values between the two constructs (above the main diagonal) were below the limit (0.9) (Henseler et al., 2015), except for one (CI-SAT), which was slightly over the limit

Table 5. Discriminant validity. Fornell-Larcker criterion (below the main diagonal) and Heterotrait-Monotrait Ratio (HTMT) (above the main diagonal)

	CI	CON	EE	PR	SQ	SAT	SV	TRUST
CI	**0.853**	0.370	0.618	0.435	0.848	0.952	0.241	0.652
CON	0.349	**0.788**	0.670	0.266	0.468	0.277	0.242	0.494
EE	0.480	0.567	**0.796**	0.302	0.639	0.466	0.173	0.538
PR	-0.353	-0.245	-0.240	**0.845**	0.353	0.354	0.043	0.382
SQ	0.713	0.432	0.509	-0.295	**0.808**	0.754	0.364	0.826
SAT	0.804	0.288	0.375	-0.296	0.660	**0.891**	0.273	0.590
SV	0.213	0.218	0.105	-0.011	0.331	0.255	**0.924**	0.360
TRUST	0.552	0.423	0.430	-0.314	0.717	0.517	0.318	**0.807**

Note. Main diagonal: in bold square root of the AVE.

5.3. Structural model

Table 6 shows the results of the evaluation of the structural model and the tests of the hypotheses. The R2 value was between 0.259 (Effort Expectancy) and 0.723 (Continuance Intention), so it exceeds in all cases the recommended minimum value (0.1) (Falk & Miller, 1992). Particularly important is the high value obtained by the R2 of Continuance Intention since this is the main dependent variable of the model. Regarding the standardized regression path weights between the factors, five of the proposed relationships obtained values above the recommended minimum and are considered significant. On the other hand, three other relationships did not have significant results (Convenience, Social value and Perceived Trust with Satisfaction) and two others (Effort Expectancy and Perceived Risk with Continuance Intention) were found to have values below the recommended value (0.2) (Chin), 1998). The size of the effect (f2) value was significant for all relationships and with a path weight greater than 0.2, medium (between 0.015 and 0.35) or large (greater than 0.35) (Chin, 1998). Finally, the model has a good fit with an SRMR value of 0.07, and therefore lower than the maximum recommended limit of 0.08 (Henseler et al., 2015).

Table 6. Evaluation of structural model (bootstrapping = 500)

Relationship-construct	Path (p-value)	R^2	f^2	SRMR
Convenience → Satisfaction	-0.011 (0.897)$^{n.s.}$		0.000	
Social Value → Satisfaction	0.034 (0.492)$^{n.s.}$		0.002	
Service Quality → Perceived Trust	0.717 (0.000)***		1.057	
Service Quality→ Satisfaction	0.589 (0.000)***		0.284	
Service Quality → Continuance Intention	0.255 (0.000)***		0.113	
Service Quality → Effort Expectancy	0.509 (0.000)***		0.350	
Perceived Trust → Satisfaction	0.089 (0.491)$^{n.s.}$		0.007	
Effort Expectancy → Continuance Intention	0.118 (0.000)**		0.037	
Satisfaction→ Continuance Intention	0.567 (0.000)***		0.641	
Perceived Risk → Continuance Intention	-0.081 (0.100)**		0.021	
Continuance Intention		0.723		
Effort Expectancy		0.259		
Satisfaction		0.440		
Trust		0.514		
SRMR				0.07

Note: *** $p \leq 0.001$; ** $p \leq 0.10$; n.s.: not significant $p > 0.10$

5.4. Testing the hypotheses

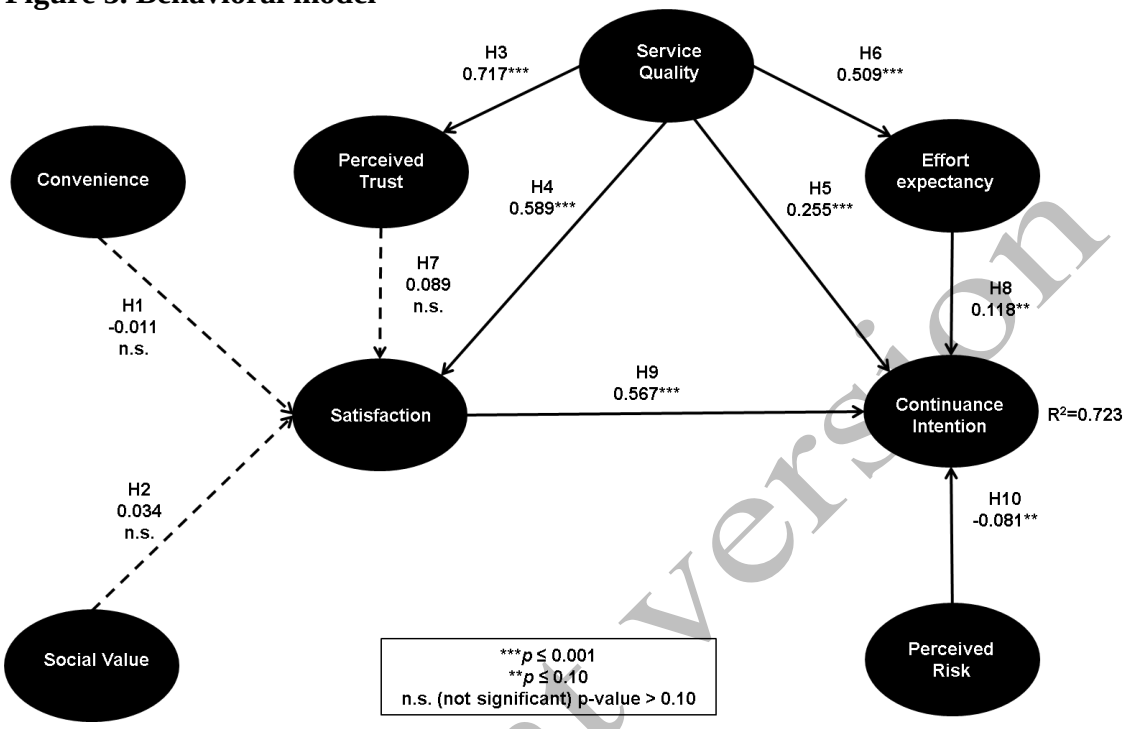
The hypotheses were tested using the structural equation modeling (SEM). Among the hypotheses, 7 of the 10 total tested effects appeared to be statistically significant (Table 6). In the first round of analysis, we monitored the impacts of convenience, social value, perceived trust, and service quality on satisfaction. Convenience, social value, and perceived trust did not have a significant relationship with satisfaction; consequently, hypotheses H1, H2 and H7 have been rejected. On the other hand, service quality did present a significant relationship with satisfaction, thereby supporting hypothesis H4 ($\beta = 0.589$; $p < 0.001$).

The relationships between service quality and perceived trust, and service quality and effort expectancy had significant results, there by supporting hypotheses H3 ($\beta = 0.717$; $p < 0.001$) and H6 ($\beta = 0.509$; $p < 0.001$).

Finally, in terms of the antecedents of continuance intention, a significant relationship was confirmed for all the variables proposed as direct antecedents. Specifically, the variable that presents the most intense relationship is satisfaction ($\beta = 0.567$; $p < 0.001$), followed by service quality ($\beta = 0{,}255$; $p< 0.001$), effort expectancy ($\beta = 0.118$; $p< 0.10$) and finally perceived risk ($\beta = -0.081$; $p< 0.10$), there by supporting hypotheses H9, H5, H8 and H10.

Figure 3 shows the results of the applied structural equation analysis and the results of the research hypotheses.

Figure 3. Behavioral model



6. Conclusions and implications

6.1. Summary of the study

The results obtained in this study confirm that it is ground-breaking research for two reasons: firstly, because it provides an analysis of the use of NFC mobile payment systems for public transportation based on the actual experience of users who employ this technology and, secondly, due to the lack of research in the scientific literature on continuance intention associated with this kind of technology.

Therefore, considering the SEM analysis, the variables that have the greatest influence on continuance intention are satisfaction, service quality, effort expectancy, and perceived risk. The other variables (i.e. convenience, social value and perceived trust) do not show a significant relationship with the aforementioned variables.

6.2. Theoretical Implications

This study contributes to the existing literature on the adoption of technological innovations, especially in terms of studies regarding the adoption of mobile payments in the urban public transportation sector. Despite the fact that numerous studies have been conducted considering the behavioral intention or the intention to use new technology in various contexts, there is little empirical evidence regarding consumers' perception in the context of mobile payments and continuance intention.

In regard to the SEM analysis, the model has proven to be parsimonious and the independent variables explain 72.30% of the variance of the continuance intention of mobile payments. Therefore, the proposed model has been confirmed to have high predictive power, especially when compared to other popular models such as the original Technology Acceptance Model (TAM) (52%) and its extensions TAM2 (37%–52%) and TAM3 (34%–53%), which are frequently used in the literature to predict the adoption of new technologies.

Lastly, the results are important for the new area of research regarding the adoption of mobile payments, as well as its continued use over time by users of urban public transportation. This study contributes valuable knowledge regarding the determination of factors that affect the decision to continue using a mobile payment system within a context of frequent use with the same provider. Accordingly, this study has confirmed that certain variables outlined in the literature, such as convenience, social value and perceived trust, do not have a significant influence on the user's decision to use this type of system. Up until the present time, it was considered to be very important for consumers to perceive the usefulness of a technology in order to use it, as well as believing that it solves their problems and fits into their daily lives (Sim et al., 2014).

6.3. Managerial Implications

In our study of the continuance intention of mobile payment systems in public transportation, the satisfaction of users derived from their experience using said system and the quality of the system is a determining factor in their decision to use it. Transportation company managers should pay special attention to these aspects in order to improve user loyalty; for example, simplifying the ticket purchase process, improving the application's available functions, or increasing the number of telephone operators that offer access to these services. In addition, effort expectancy and perceived risk have also been established as determining factors, and managers should therefore improve usability and security systems by employing more secure authentication systems and even safety seals in order to mitigate the aversion to risk in the future.

Considering all of the above, this study is especially relevant within the business world for various reasons. On the one hand, it is clear that public transportation operators, including buses, trams and subways, are interested in adopting this technology due to its evident associated benefits, which have been explained in this article. Drawing conclusions based on the commercial experience of NFC in Malaga will therefore be undeniably useful. For example, one of the biggest challenges facing transportation companies is the elimination of cash payments, since collection is expensive and complicated. NFC mobile payment systems are clearly helping transportation operators to achieve this objective. On another note, this research has relevant implications as to whether using the NFC system to make mobile payments will constitute a standard in the future of public transportation, or whether this system will not meet users' expectations, thereby requiring the analysis of other alternatives. In this regard, although the experience in Malaga only spans two years, the increase in the number of users, their satisfaction, their assessment of the system's quality, and their intention to continue using it indicates that the system could be extended to many other users in the short term.

7. Limitations and Future Research

Despite its contributions, this study is not without its limitations; however, these limitations can provide fruitful avenues for further research.

Firstly, our work focuses on a sample of public transportation users in the city of Malaga with experience using the NFC mobile payment system, which limits the generalization of the results applied to other countries and cultures. The study could be replicated in other countries that have a similar situation to Spain, considering possible differences between cultures and establishing different levels of acceptance and actual use of the technology.

To confer greater external validity to our results, a comparative study could be conducted on different payment systems, establishing a categorization and user profile for each system, including other mobile technologies that are being considered as substitutes for credit card payments.

In addition, the data collection method used in this study is based on a transversal focus, which impedes the analysis of the evolution of user behaviors over time. A longitudinal focus would allow us to corroborate the robustness of the relationships and established constructs and confirm the evolution of intention from a temporary perspective.

Lastly, we propose including an analysis of other possible perceived benefits, in addition to the moderating effects of variables such as gender, age, and experience using similar payment tools.

Acknowledgements

The authors would like to acknowledge the assistance of the Malaga City Council, Empresa Malagueña de Transportes and Cátedra de Gestión del Transporte (Transport Management Lab) of the University of Malaga, with the data collection.

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