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To Use or Not to Use? Investigating What Drives Tourists to Use Mobile Ticketing Services in Tourism

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Abstract: The advantages associated with mobile ticketing solutions are undeniable; however, most of these solutions are designed for the local population without taking into account the specific needs of tourists. Therefore, this study fills an important research gap in the literature by assessing the adoption drivers of mobile ticketing services by tourists and pointing out possible directions to the design of such services. The proposed model includes constructs of the technology acceptance model (TAM), diffusion of innovations (DOI) theory, and others widely disseminated in the literature on mobile payments, such as mobility. The model was empirically tested through an online survey, and Structural Equation Modeling (SEM) was applied to analyze the data. The results show that the intention of tourists to use mobile ticketing services is positively affected by the perceived usefulness and mobility. The survey findings also describe additional services that respondents value in a mobile ticket service for tourists, both in normal and in pandemic contexts, useful to shape future mobile ticketing solutions for tourists.

Keywords: adoption factors; TAM; DOI; empirical study; structural equation modeling; pandemic

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1. Introduction

Over the past few decades, urban areas have seen remarkable development at many levels, making them desirable places to live in. It is estimated that around 2050, 68% of the world population will live in urban areas [1]. Parallel to the demographic increase in urban centers, the world has increasingly enjoyed tourist activity [2]. Since the 1990s' decade, international tourist arrivals more than tripled [3] and the importance of the sector in many European economies today surpasses 10% of their gross domestic product (GDP). This sustained growth was somewhat held back by the emergence of the COVID-19 pandemic [4], with a drop in tourist arrivals to Europe between 70.32% and 81.76% in 2020 compared with 2019 [5]. However, the sector is already recovering and countries are starting to define tourism recovery strategies [6,7].

The fast growth the tourism sector is experiencing is placing tough challenges on many cities worldwide as many of them were not planned to receive such a number of tourists. Those challenges range from residential pressure in the city centers, also known as tourism gentrification, to mobility issues such as the overuse of road networks or public transport [8]. Nowadays, more than ever it is important to foster the utilization of public transport by tourists at their destination, given the pressure that tourism is putting on transport infrastructures worldwide and in order to contain the CO_2 emissions from tourism [9]. Public transport, at the same time, must become better and more attractive [9].

It is clear that the attractiveness of public transport increases as it becomes easier to use and modern mobile ticketing service solutions are able to free customers from difficult purchase decisions, allowing easier access to services [10]. When compared with traditional ticketing systems, mobile ticketing has several advantages. It allows ubiquitous and remote access to payments, avoiding queues, and replacing banknotes and coins. Service providers

can also achieve operational and productivity gains by increasing performance on closed gate systems and improving bus boarding times [11].

Despite their clear advantages, mobile ticketing services available worldwide tend to focus on the needs of local users [12], disregarding the needs of tourists. While a local user of public transport may have certain needs, those needs may be completely different from those of a tourist visiting a city [13]. Additionally, a user may be willing to adopt such technologies in their local town but not when they are abroad or vice versa.

Even though there are some studies on the adoption of mobile ticketing services [14–17], these are applied to their use by locals and not by tourists and this difference in the context of use cannot be overlooked. In this sense, this article fills an important research gap in the literature by assessing the adoption of mobile ticketing services by tourists. The proposed model includes constructs from the Technology Acceptance Model (TAM), the diffusion of innovations (DOI) theory, and others widely suggested in the mobile payments related literature, such as mobility. Empirical data for the study were collected through a survey in a European country, Portugal, resulting in 351 valid answers.

In addition to explain and predict the initial adoption behavior, this article also explores additional services that can be integrated in a mobile ticketing application for tourists. The respondents were asked about the usefulness of accessing information on public transport and tourist attractions and what type of information and features they would like to have access to, in addition to payment and validation of travel tickets. Opportunistically, it also explores how a mobile ticketing service could help tourists use public transport in the context of a global pandemic such as COVID-19.

This article is organized as follows: Section 2 presents a literature review on tourist use of public transport, mobile ticketing in public transport, and research studies on mobile ticketing adoption. The Section 3 presents the proposed research model and its hypotheses. Then, the Section 4 details the research methodology that was followed, and the results are presented in Section 5. Finally, Sections 6 and 7 present the discussion and conclusion, respectively.

2. Literature Review

Considering the constant technological evolution and change, leading companies are always seeking to improve their technological applications in order to increase their benefits and profits [18]. In the case of tourism, a growing number of tourist attractions have adopted technological applications such as artificial intelligence (AI), cloud computing, and the Internet of Things (IoT) to enhance the tourist experience. For example, virtual reality (VR) technology can offer tourists a physically, spiritually, and emotionally integrated tourism experience [18].

The acceptance of such technologies by consumers directly depends on several aspects, namely the availability of the technology, its convenience and security as well as the consumers' needs. Hence, and due to these distinct aspects, several studies have been developed to fully understand the consumers' acceptance of new technologies [19–22], approaching different technology adoption models and theories.

The Technology Acceptance Model was suggested in [20] and consists of one of the most popular theories to explain technology adoption by consumers. It addresses two beliefs in particular: perceived usefulness and perceived ease of use. Nonetheless, the consumer's belief regarding a specific technology can also be influenced by other factors, called TAM's external variables.

In the literature, it is possible to verify that several authors have focused on the study of adoption factors for mobile payments, having proposed several additions and modifications to the original model of TAM [21–23]. For example, in [24] it is stated that some research studies propose further factors considered specific to the context of mobile payments, such as mobility, network externalities, cost, security, and trust.

The theory of Diffusion of Innovations (DOI) introduced by [19] explains how an innovation is diffused through various channels over time and by the various members of

a specific social system. The author identified five attributes that effectively explain the adoption of an innovation: observability, relative advantage, compatibility, trialability, and complexity. The DOI theory states that both the innovation and the adoption happen after several stages, more precisely after understanding, persuading, deciding, implementing, and confirming. These different stages led to the S-shaped adoption curve of innovators, early adopters, early majority, late majority, and laggards.

Over the years, several theoretical models have been developed in order to explain factors that determine the adoption of mobile commerce and mobile payments in general [23,25–27]. However, to the best of the authors' knowledge, very few studies have been carried out on the adoption of mobile ticketing and none in the context of tourism.

The study presented in [24] explains the intention to use mobile commerce by analyzing the mobile ticketing in the public transport sector. According to the results obtained, the authors concluded that mobility and contextual elements, such as lack of money exchanged, sudden need to use public transport, expiry of a travel card, and being in a hurry, play a very important role in the adoption of mobile services. In a more recent study, [28], it is claimed that the benefits from adopting mobile ticketing services are facilitated by the context of use and that ease of use and compatibility factors affect the use intention.

In turn, it has been demonstrated that the adoption of mobile ticketing is influenced by the benefit, i.e., perceived usefulness and perceived ease of use, and potential loss, which is a perceived risk, of the mobile ticketing solution [14]. In [29], the authors suggested that the attributes of the DOI theory [19] have a significant influence on the behavioral intention of consumers in terms of mobile ticketing services adoption, except for the complexity construct, and that the riskiness significantly affects both the behavioral intention and the adoption of mobile ticketing services.

On the other hand, in [22], a new model, designated as the Integrated Model on Mobile Payment Acceptance (IMMPA), was proposed and it was concluded that the intention to use a technology is affected by the ease of use, usefulness, and security of that technology; and the usefulness is affected by ease of use and compatibility with consumers' needs and values and their attitudes. The authors in the study described in [30] assessed the individual intention to use a flight ticket booking app on mobile devices and demonstrated that the perceived usefulness is the strongest determining factor, followed by the ease of use. Finally, in the study presented in [31], the determining factors that impact the intention of passengers to use the Spider Card based on the UTAUT model were identified, integrating perceived sacrifice and perceived convenience as a part of the perceived value.

Although there are numerous studies on mobile commerce and mobile payment adoption, this review let one realize that there are just a few studies on mobile ticketing adoption in public transport, none of which apply to the context of tourism. Therefore, this work aims to overcome such limitations by studying the factors that may influence the adoption of mobile ticketing services by tourists, which led to the proposed research model.

3. Research Model and Hypotheses

This section presents the hypotheses established for the proposed research model based on the aforementioned literature and technology acceptance theories.

3.1. Perceived Usefulness and Perceived Ease of Use

Perceived usefulness consists of the potential user's subjective likelihood that the use of a specific technology will improve his/her action, while perceived ease of use is related to the degree to which the potential user expects the technology to be quite effortless [20]. In the TAM, perceived usefulness is an important predictor that affects behavioral intention to use. The TAM stresses that perceived ease of use is a determinant of perceived usefulness, whereby users tend to consider that a system is more useful and can improve their performance when it is easy to use and requires minimal effort and time to learn. Previous studies, such as [22,24], provide evidence on the relevance of ease of use and usefulness for predicting the acceptance of mobile payment services. In this sense, here

it is considered that tourists recognize the usefulness of a mobile ticketing solution if it is easy to use and does not require much effort and time to learn. In addition, it is believed that tourists adopt a mobile ticketing solution in the context of tourism if they recognize it as useful, provides them advantages, and improves their tourism experience. Therefore, the following hypotheses were formulated:

H1. *Perceived ease of use has a positive impact on the perceived usefulness of mobile ticketing services for tourists.*

H2. *Perceived usefulness has a positive impact on the intention to use mobile ticketing services by tourists.*

3.2. Compatibility

According to the DOI theory suggested in [19], compatibility measures the degree to which an innovation is perceived to be consistent with the existing values, past experiences, and the current needs of potential adopters. An innovation can only be seen as advantageous if it meets the needs of users [22]. Existing research shows positive effects of compatibility on both the attitude toward using a technology [32] and perceived usefulness [33,34]. It is believed in this study that if tourists perceive that the mobile ticketing solution is compatible with their way of doing tourism, with their habits, and with other uses they make with the mobile phone, they consider the solution to be useful. Therefore, it is considered that compatibility has an indirect effect on tourists' intention to use mobile ticketing through perceived usefulness. Therefore, the following hypothesis was formulated:

H3. *Compatibility has a positive impact on the perceived usefulness of mobile ticketing services for tourists.*

3.3. Mobility

The most significant feature of mobile technology is mobility, that means the ability to access services ubiquitously, on the move, and through wireless networks and various devices such as smartphones and tablets [32]. Mobility affords the benefits of time and place independence, focusing on the advantages of mobile technology use and its availability anywhere at any time [35]. Extant research shows positive influence of mobility on the intention to use mobile payments either directly [32] or indirectly [34]. Tourists need to buy tickets or get information about schedules or delays as they are in a place they do not know well and mobile technologies can make travel easier. Access to these services anytime and anywhere plays a fundamental role in the tourist experience, and that is why it is believed that tourists would adopt a mobile ticketing solution that would provide them with advantages such as ubiquity, avoiding queues, and reducing the need to purchase tickets in person. Therefore, the following hypothesis was formulated:

H4. *Mobility has a positive impact on the intention to use mobile ticketing services by tourists.*

3.4. Proposed Research Model

Based on the literature review and the formulated hypotheses, the research model depicted in Figure 1 is proposed. In the model, the perceived usefulness and perceived ease of use of the TAM theory, the compatibility of the DOI theory, and the mobility factor based on empirical findings reported on mobile payments literature were included as determinants. The next section presents the research methodology that was followed.

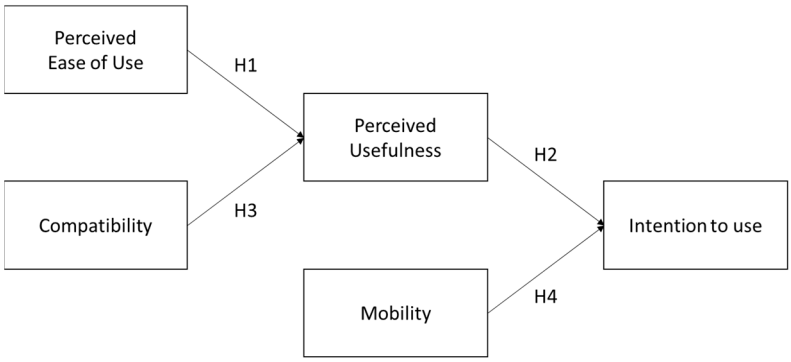

Figure 1. Research model proposed in this study developed according to the formulated hypotheses (Hi).

4. Research Methodology

4.1. Procedure

Data were collected using quantitative methods, more precisely through the application of a questionnaire. The questionnaire was tested through a pilot survey in a sample of 30 respondents. After completing the questionnaire, respondents were asked to mention difficulties in interpreting and answering the questions asked. Their feedback led to the reformulation of some questions in order to guarantee their clarity. The final version of the questionnaire was administered online through the Google Forms platform and disseminated to the Portuguese population through email and social networks. The questionnaire was available between the 5th and 18th of June 2020, having received 351 complete and valid responses. Structural Equation Modeling (SEM) was applied to analyze the data gathered from the survey. Therefore, the sample size can be considered sufficient as it meets the conditions established in [36], where it is defended the need for at least 10 participants per predictor construct. In addition, [37] suggests a sample size above 100, preferably above 200, in structural equation modeling analysis.

4.2. Questionnaire

The questionnaire is divided into five sections; see the questionnaire structure and questions in Appendix A. The first section includes general demographic questions, such as gender, age, education, occupation, and past mobile payment experience. Section 2 is related to the characterization of tourists' habits, such as frequency of tourist trips, means of transport used at the destination, and ways of obtaining information during tourism.

Section 3 explores the factors affecting the acceptance of a mobile ticketing service in the context of tourism. The measurement items under the constructs "Perceived Usefulness", "Perceived Ease of Use", "Compatibility", "Mobility", and "Use Intention" were adapted from prior relevant studies. As it can be perceived from Table 1, a set of 20 statements were included in the questionnaire so that respondents could assess a group of factors in the form of a five-point Likert scale, ranging from totally agree to totally disagree.

Table 1. Constructs and measurement items included in the developed questionnaire.

Construct	Statement #	Statement
P. Ease of Use	1	Learning to use a mobile ticketing app for tourists would be easy for me.
P. Ease of Use	2	I think it would be easy to purchase tickets with a mobile ticketing app for tourism.
P. Ease of Use	3	I think it would be easy to validate tickets with a mobile ticketing app for tourism.

Table 1. *Cont.*

Construct	Statement #	Statement
P. Usefulness	1	Using a mobile ticketing app for tourists would make the ticket purchase and validation process faster.
P. Usefulness	2	Using a mobile ticketing app for tourists would make it easier to purchase and validate tickets.
P. Usefulness	3	I consider being more effective to buy tickets with the smartphone.
Compatibility	1	I think that buying tickets with the smartphone is compatible with other uses that I make with a mobile phone.
Compatibility	2	I think the smartphone is a suitable device to purchase tickets.
Compatibility	3	I consider that mobile tickets are compatible with my habits.
Compatibility	4	I consider that mobile tickets are compatible with the way I make tourism.
Mobility	1	I believe it is possible to buy mobile tickets at any time.
Mobility	2	I believe it is possible to buy mobile tickets anywhere.
Mobility	3	I believe that the purchase of mobile tickets would reduce queues.
Mobility	4	I believe that I can substitute the need for cash or travel card by purchasing a mobile ticket.
Intention to Use	1	I would use a mobile ticketing app for tourists to purchase tickets in the city where I am doing tourism.
Intention to Use	2	I would use a mobile ticketing app for tourists to validate tickets in the city where I am doing tourism.
Intention to Use	3	I would use a mobile ticketing app for tourists if I were unfamiliar with the process of buying and validating tickets in the city where I am doing tourism.
Intention to Use	4	I would use a mobile ticketing app for tourists if public transport only has information in a language I do not speak.
Intention to Use	5	I would use a mobile ticketing app for tourists if I do not know the public transport network of the city where I am doing tourism.
Intention to Use	6	I believe that a mobile ticketing app for tourists would improve my tourist experience.

Section 4 explores additional features that tourists value in a mobile ticketing application, including information on public transport and tourist attractions. Finally, in Section 5, the current pandemic situation (COVID-19), during which the questionnaire was administered, is addressed in order to understand how a mobile service of this type could help tourists in the use of public transport during a global pandemic. Participants are asked, for example, about the usefulness of information about the vehicle's occupation, disinfection, number of confirmed cases in the tourist city, and alerts from local health authorities.

4.3. Data Analysis Technique

With the information obtained through the questionnaires, descriptive statistics were applied not only to describe the sample collected, but also to statistically describe the respondents' opinion on the features that a public transport mobile ticketing service for tourists should have.

After completing the descriptive statistical analysis, a Structural Equation Model was built, which is composed of a Confirmatory Factor Analysis (CFA) and by a Structural Model (SEM) [36], aiming to answer which factors influence the acceptance of a public transport mobile ticketing service for tourists. For that matter, a multivariate statistical analysis with SPSS version 22 (IBM Corporation, 2013) and AMOS version 22 was applied. CFA was implemented to find a robust factorial structure that fits the data under analysis. Then, SEM was accomplished to confirm the study hypothesis based on theoretical premises.

The confirmation of the hypothesis was conditioned by the assessment of the *p*-value associated with each path coefficient (β).

CFA establishes previous relations between observed and latent variables, attempting to reproduce with the most possible accuracy the population covariance matrix of the measured variables [38]. In this study, CFA was used as a tool for scale validation, one of its main purposes [39], by building and assessing a measurement model. Structural Equation Modeling (SEM) is a combination of CFA and multiple regression [39] and was used to confirm the study hypothesis by establishing dependence relations between latent variables.

5. Results

5.1. Sample Characterization

A total of 351 participants were surveyed (see Table 2); the sample was composed of 200 (57.0%) females and 151 (43.0%) males. There were 52.1% of the respondents aged less than 30 years old, 22.8% aged between 31 and 40, 12% aged between 41 and 50, 10.8% aged between 51 and 60, and 2.3% were more than 61 years old. As for the composition of the sample, the predominance of young people and young adults is consistent with the characteristics of common users of technological services [22,40–42].

Table 2. Sociodemographic characteristics of the questionnaire respondents.

Sociodemographic Characterization	n	%
Gender		
Female	200	57.0%
Male	151	43.0%
Age Group		
≤30	183	52.1%
[31–40]	80	22.8%
[41–50]	42	12.0%
[51–60]	38	10.8%
[61–70]	7	2.0%
≥71	1	0.3%
Education		
No education	1	0.3%
Secondary education	56	16.0%
High education	294	83.8%
Occupation		
Unemployed	6	1.7%
Student	96	27.4%
Working-student	5	1.4%
Worker	241	68.7%
Retired	3	0.9%
How long have you been using smartphones		
Do not have a smartphone	10	2.8%
<6 months	1	0.3%
[6–24] months	4	1.1%
>24 months	336	95.7%
Have you ever made a payment with a mobile app		
No	30	8.5%
Yes	321	91.5%
Frequency of tourism travels		
Very frequently (at least 2 times in the last year)	154	44%
Frequently (once a year)	144	41%
Occasionally (1 time in the last 2 years)	35	10%
Rarely (1 time in the last 5 years)	18	5%

Most of the participants have higher education (83.8%) and are workers (68.7%). Almost all participants (95.7%) have used smartphones for more than 24 months, indicating great familiarity with the technology. A large part of the sample (91.5%) had already made payments using mobile applications, which is indicative of the respondents' knowledge of mobile payment solutions. Almost all have a driving license (94.6%), but a more reduced proportion own a car (76.4%).

Regarding the frequency of travel in tourism, 44% of respondents answered that they travel in tourism at least twice during the year, 41% once a year, 10% once in the last two years, and 5% only once in the last five years. This reveals that the respondents are people who travel frequently for tourism and, therefore, are well aware of the needs they have when they are in touristic destinations.

Regarding the means of transport usually used in the tourist destination, walking was the most frequent response (85%), followed by public transport (67.2%), then Uber or similar (49%), and private car (42%). This fact demonstrates the importance of the use of public transport by tourists over the remaining means of transport.

The internet was the most common source of information for mobility at tourism destinations (59.8%) and tourist attractions (82.3%). Family and friends, touristic guides, and paper maps and roadmaps followed the internet as the most used means for getting information regarding tourism destination and its attractions. Mobile apps did not reveal to be a frequently used source of information, with 27.6% prevalence for responses concerning mobility at tourism destinations and 25.4% for responses related to tourism attractions.

5.2. Features of a Mobile Ticketing Services for Tourism

As already mentioned, the developed questionnaire was also used to ask about possible features that respondents would value in a mobile ticketing solution for tourists in both normal and pandemic contexts. Respondents were asked to evaluate, according to a five-point Likert scale, ranging from "Totally useless" to "Very useful", the usefulness of: (i) specific functionalities of a mobile ticketing solution for tourists, (ii) type of information provided about public transport, (iii) type of information provided about tourist attractions, and (iv) type of information related to the pandemic situation in the visiting city.

Respondents showed a positive attitude towards the usefulness of a transport ticketing solution oriented to tourism (see Figure 2). They considered useful or very useful a tourist-oriented mobile ticketing solution providing information on public transport (96%), allowing to purchase (94%) and validate (90%) travel tickets, providing information for touristic attractions (90%), allowing to purchase (93%) and validate tickets (90%) for touristic attractions, and to purchase combined packs of tickets for public transport and touristic attractions (90%).

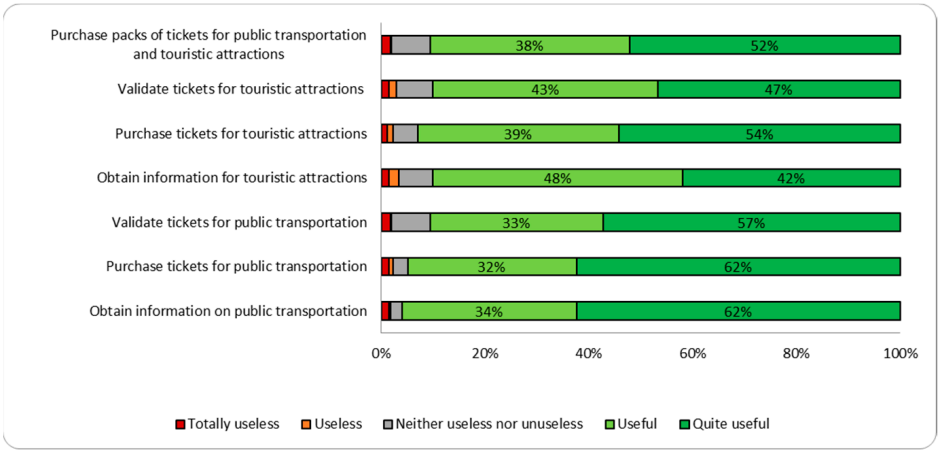

Figure 2. Respondents' assessment of the usefulness of potential mobile ticketing application features.

Regarding the most relevant information that the mobile ticketing solution should provide about public transport, respondents valued the most information about schedules (97%), travel time (97%), waiting time between transfers (96%), transport frequency (96%), alternative means of transport (96%), trip cost (96%), journey path (95%), network map (95%), accessibility for people with reduced mobility (93%), instructions on ticket purchase (92%) and validation (91%), network fares (91%), ticket office location and schedule (91%), vehicle occupation (86%), operator contacts, e.g., customer support, (85%), conditions of use for children (82%), and conditions of use for pets (69%).

Regarding tourist attractions, respondents considered price (95%), schedule (95%), and location (94%) of the touristic attractions the most useful information to be provided by the mobile ticketing service. Descriptions of tourist attractions (87%), photographs (80%), and popularity (74%) were also valued.

The participants considered useful or very useful that a public transport mobile ticketing service for tourists during a global pandemic context provides information regarding: vehicle occupation (94%), specific rules for the use of public transport (93%), alerts and notifications from local authorities (92%), hospital locations (89%), disinfection of the vehicles (86%), location of hydroalcoholic dispensers (79%), and number of confirmed cases in the city (73%).

5.3. Measurement Model

The hypothesized model included 20 observed items measuring five latent constructs: "Perceived Usefulness", "Perceived Ease of Use", "Compatibility", "Mobility", and "Use Intention". A Confirmatory Factor Analysis was used to validate an instrument to measure the factors affecting the adoption of a public transport mobile ticketing service for tourists.

Convergent validity was assessed in accordance with the suggestions presented by [36] by examining item loadings (λ). These were estimated according to the maximum likelihood method after checking for item symmetry, between −2 and 2. This estimation method has proven to be robust even when this assumption is not met [43]. Each coefficient measured the relative contribution of each indicator on the construct for the measurement model (CFA).

Specifically, for CFA, loadings (λ) were assessed as a measure of association of each observed variable with its latent variable, considering $\lambda > 0.50$ [44]. As indicated in Table 3, the estimated loadings for all items were $\lambda > 0.50$ and statistically significant at $p < 0.001$ level. Correlations between latent variables varied between $\rho = 0.72$ and $\rho = 0.92$, considered very high.

Table 3. Reliability and confirmatory factor item loadings to assess the reliability and validity of the proposed model.

Construct	Item	Standardized Loading	Cronbach α (>0.7)	AVE (>0.5)	CR (>0.7)
Perceived Ease of Use	PEoU1	0.58	0.901	0.759	0.904
	PEoU2	0.67			
	PEoU3	0.66			
Perceived Usefulness	PU1	0.61	0.901	0.716	0.883
	PU2	0.63			
	PU3	0.73			
Compatibility	Com1	0.69	0.937	0.766	0.929
	Com2	0.70			
	Com3	0.74			
	Com4	0.75			
Mobility	Mob1	0.68	0.829	0.547	0.827
	Mob2	0.71			
	Mob3	0.58			
	Mob4	0.65			

Table 3. *Cont.*

Construct	Item	Standardized Loading	Cronbach α (>0.7)	AVE (>0.5)	CR (>0.7)
Use Intention	UI1	0.78	0.916	0.634	0.910
	UI2	0.78			
	UI3	0.84			
	UI4	0.64			
	UI5	0.66			
	UI6	0.75			

Following [36]'s suggestion, the Cronbach α values, average variance extracted (AVE), and composite reliability (CR) were observed for each latent variable to assess the model reliability and validity. In [36], the authors recommend that the Cronbach α values should be >0.70, AVE > 0.50, and CR > 0.70. Table 3 indicates that all measures clearly exceeded the recommended minimum values, which ensures the reliability and validity of the constructs.

To assess the fit of the measurement and structural models, the following absolute adjustment measures were used: chi-square (χ^2/df), root mean square error of approximation (RMSEA), the goodness of fit index (GFI), and the Tucker–Lewis index (TLI). Parsimony-adjusted, which compensates for the complexity of the models [44,45], namely the comparative fit index (CFI), was also used. As indicated in Table 4, the fit results accomplished all the established criteria. Specifically, the chi-square/df ratio (2.624) was smaller than the recommended value of 3.0 [46]. The RMSEA value (0.068) was lower than the cut-off value of 0.08 [47,48]. All the other indices, i.e., TLI, CFI, and GFI, were above the recommended inception value of 0.90 [48].

Table 4. Results of the goodness of fit indices for the proposed measurement and the structural models.

Fit Measure	Criterion	CFA	SEM
Chi-squared/degrees of freedom (χ^2/df)	χ^2/df < 3	2.624	2.738
Root mean square error of approximation (RMSEA)	RMSEA < 0.08	0.068	0.070
Tucker–Lewis Index (TLI)	TLI > 0.90	0.956	0.953
Comparative fit index (CFI)	CFI > 0.90	0.965	0.962
Goodness of fit index (GFI)	GFI > 0.90	0.902	0.900

The obtained statistical results allow to conclude that the measures used in this research strongly confirm reliability and validity, being adequate to assess the proposed structural model.

5.4. Structural Model

Once the existence of the factors, i.e., constructs, was confirmed through the Confirmatory Factor Analysis, a structural equation model (SEM) was used to confirm the study hypothesis. Table 4 presents the results of the goodness of fit indices of the structural model test, showing that the fit results accomplish all the suggested criteria, namely, χ^2/df = 2.738 (<3.0), RMSEA = 0.070 (<0.80), TLI = 0.953 (>0.90), CFI = 0.962 (>0.90), and GFI = 0.90 (>0.90).

The synthesis of the results obtained from testing the hypotheses is depicted in Table 5, supporting all hypotheses formulated for this study. Perceived ease of use has a positive impact on the perceived usefulness of mobile ticketing services for tourists (β = 1.42; $p < 0.001$), confirming Hypothesis 1, which in turn has a positive impact on the intention to use mobile ticketing services by tourists (β = 0.17; $p = 0.036$), confirming Hypothesis 2. Compatibility has a positive impact on the usefulness of mobile ticketing services for tourists (β = 2.49; $p < 0.001$), confirming Hypothesis 3. Finally, mobility has a positive

impact on the intention to use mobile ticketing services by tourists (β = 0.85; p = 0.009), supporting Hypothesis 4.

Table 5. Results obtained from testing the formulated hypothesis.

Hypothesis	Path	Estimate (β)	S.E.	*p*-Value	Result
H1	P. Ease of use → P. Usefulness	1.42	0.34	$p < 0.001$ *	Supported
H2	P. Usefulness → P. Use intention	0.17	0.08	$p = 0.036$ *	Supported
H3	Compatibility → P. Usefulness	2.49	0.55	$p < 0.001$ *	Supported
H4	Mobility → Use intention	0.85	0.32	$p = 0.009$ *	Supported

Note: * statistically significant ($p < 0.05$); S.E.—standard error.

6. Discussion

This study examined individual intention to use a mobile ticketing service for tourists. Overall, four hypotheses were defined, being the obtained SEM results shown in Figure 3. The SEM approach revealed a significant and positive effect on perceived usefulness of mobile ticketing for tourists by perceived ease of use at $p < 0.05$, which corresponds to H1. This conclusion is in line with the conclusions corroborated in TAM [20] and the studies of [14,22,30]. In this case, users tend to consider that a mobile ticketing service for tourists is more useful and can improve their performance when it is easy to use and requires minimal effort and time to learn.

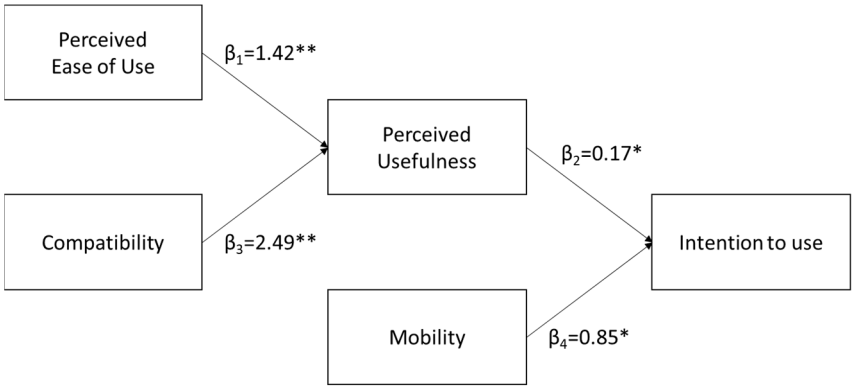

Figure 3. Results obtained for the proposed structural model.

Further analysis revealed that perceived usefulness had a significant and positive influence on the intention to use a mobile ticketing service for tourists, which means that H2 is supported by the data. Respondents indicated that they are more likely to use a mobile ticketing app for tourists if they find the app to be useful in helping them to buy and validate tickets more quickly. In addition, they expect it to be easier and more effective to buy and validate travel ticketing in the city where they are doing tourism with a mobile ticketing app for tourists. The direct impact of perceived usefulness on user intention is widely reported in other studies, such as in [14,22,30,32].

According to the results, compatibility had a significant and positive influence on the perceived usefulness of a mobile ticketing service for tourists at $p < 0.05$, which supports H3. Respondents indicated that they find a mobile ticketing service for tourists useful as it is compatible with the other uses of their mobile phone, their habits, and the way of doing tourism. This positive effect of compatibility on perceived usefulness has been demonstrated in other studies, for example, in [33,34].

The results also demonstrated a positive and significant influence of mobility on the intention to use a mobile ticketing service for tourists. This outcome supports H4 and goes in line with previous research [32]. Individuals confirmed their willingness and intention to use such an app considering the benefits of time and place independence and

its availability anywhere at any time. They also recognize that the advantages of avoiding queues and replacing cash or travel cards would make them use a mobile ticketing app in a tourism context.

7. Conclusions

The advantages associated with mobile ticketing solutions are unquestionable, however little is known about its application to the tourism sector. This article fills an important research gap by studying the factors that influence the adoption of mobile ticketing services by tourists, highlighting several implications for research and practice.

From the academic perspective, a research model that integrates constructs of the TAM theory such as perceived usefulness and perceived ease of use, of the DOI theory such as compatibility, and of empirical findings reported on mobile payments literature such as mobility, was proposed. Empirical data for the study were collected through a survey resulting in 351 valid answers and an SEM approach was used in the data analysis. The results revealed that the proposed model has good explanatory power, confirming its robustness in predicting tourists' intentions to adopt mobile ticketing services. All constructs significantly influence, directly or indirectly, the intention to use a mobile ticketing service for tourists. Therefore, the proposed model can be used by researchers as a base model in future research.

From the managerial perspective, understanding the key constructs is crucial to design, refine, and implement future versions of mobile ticketing services for tourists. It was confirmed in the present study that the perceived usefulness exerts a great influence on tourists with regard to the intention to engage with such solutions. Tourists should be able to buy and validate tickets more quickly, easily, and effectively than with traditional methods. Additionally, using mobile solutions should be easy and require no effort and time to learn. Usually, tourists are in not very familiar places and are looking for simple, useful, and easy to use solutions that help them to have a good tourist experience.

Managers should also be able to design mobile solutions that are compatible with the other uses that tourists make of their mobile phone, their habits, and the way of doing tourism. If tourists realize that the mobile ticketing solution is compatible with their day-to-day tourism and does not affect their habits and customs, the likelihood of using the mobile ticketing service is greater. Similarly, managers should be able to demonstrate the benefits of mobile services, such as time and place independence and avoiding queues and cash. These are important drivers in encouraging the use of such services in a tourism setting.

Along with these findings, the survey results also provided insights on additional services that could be integrated in a mobile ticketing application for tourists. In the context of tourism, users want to have access, in addition to the purchase and validation of public transport tickets, to information on transport and tourist attractions. They would like to have information about timetables, prices, location of tourist attractions and maps of the transport network, travel time, and frequency of transport. When carrying out tourism in the context of a pandemic, access to information such as vehicle occupation, specific rules for the use of public transport, alerts and notifications from local authorities, and hospital locations are valued.

Despite the significant findings obtained from this study, some limitations do exist that might guide the direction of future research. First, it would be interesting to apply the same questionnaire and methodology to other countries in order to be able to compare the differences between countries. Second, it would be interesting to develop and test a prototype of a mobile ticketing service for tourists based on the findings achieved with this study.

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Institutional Review Board Statement: Ethical review and approval were waived for this study/research due to the following reasons: (1) our research project was on humans; however, it did not include any private sensitive or personal information about the participants in the exploratory study; (2) ethics committee or institutional review board approval is not requested by University of Porto (UP) for research projects conducted by postgraduate students; (3) this study has been carried out within the framework of the second author's postgraduate studies and under the professors' (first and third authors) supervision and close monitoring. All postgraduate students fully comply with the ethical regulations of UP.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Online questionnaire structure and questions.

Sociodemographic Characterization
Gender (Possible answers: male; female) Age group (Possible answers: less than 30; between 31 and 40; between 41 and 50; between 51 and 60; between 61 and 70; more than 71) Education (Possible answers: no education; basic education; higher education; university education) Occupation (Possible answers: student; worker; unemployed; retired) How long have you been using smartphones? (Possible answers: I do not have smartphone; less than 6 months; between 6 months and 2 years; more than 2 years) Have you ever made a payment with a mobile app? (Possible answers: Yes; No) Do you have a driving license? (Possible answers: Yes; No) Do you own a car? (Possible answers: Yes; No)
Characterization of tourist habits
How often do you travel for tourism? (Possible answers: Rarely; Occasionally; Frequently; Very frequently) Assess, for your agreement, the following statement: (Possible answers: totally disagree; disagree; neither agree nor disagree; agree; totally agree) When I visit a tourist spot, I like to have contact with the locals. What means of transport do you use to move around the destination? (Possible answers: walking; smooth modes; private transports; car renting; public transports; touristic transports) How do you obtain this information when you are traveling for tourism? (Possible answers: friends and family; local inhabitants; tourist guides; apps; internet) If you wish, you can indicate which apps you use to obtain information on mobility in tourism
Factors affecting the adoption of a mobile ticketing application
Assess, for your agreement, each of the following statements: (Possible answers: totally disagree; disagree; neither agree nor disagree; agree; totally agree) Learn to use a mobile ticketing app for tourists would be easy for me. I think it would be easy to purchase tickets with a mobile ticketing app for tourism. I think it would be easy to validate tickets with a mobile ticketing app for tourism. Using a mobile ticketing app for tourists would make the ticket purchase and validation process faster. Using a mobile ticketing app for tourists would make it easier to purchase and validate tickets. I think it is more effective to buy tickets via mobile phone. I believe that the purchase and validation of tickets is compatible with other uses that I make with a mobile phone. I think the smartphone is a suitable device to purchase tickets. I believe that mobile tickets are compatible with my habits.

Table A1. *Cont.*

Sociodemographic Characterization
I believe that mobile tickets are compatible with the way I make tourism.
I believe it is possible to buy mobile tickets at any time.
I believe it is possible to buy mobile tickets anywhere.
I believe that the purchase of mobile tickets would reduce queues.
I believe that I can substitute the need for cash or travel card by purchasing a mobile ticket.
I would use a mobile ticketing app for tourists to purchase tickets in the city where I am doing tourism.
I would use a mobile ticketing app for tourists to validate tickets in the city where I am doing tourism.
I would use a mobile ticketing app for tourists if I were unfamiliar with the process of buying and validating tickets in the city where I am doing tourism.
I would use a mobile ticketing app for tourists if public transport only had information in a language I do not speak.
I would use a mobile ticketing app for tourists if I do not know the public transport network of the city where I am doing tourism.
I believe that a mobile ticketing app for tourists would improve my tourist experience.
Can you please indicate what other factors influence your adoption of a mobile ticketing application?
Functionalities of a mobile ticketing application for public transport oriented to tourism
Evaluate, concerning its usefulness, the following functionalities of a mobile transport ticketing application oriented to tourism:
(Possible answers: very useless; useless; neither useful nor useless; useful; very useful)
Get information on public transport
Purchasing public transport tickets
Validate public transport tickets
Get information about tourist attractions
Purchasing tickets for tourist attractions
Validate tickets for tourist attractions
Purchasing packs of public transport tickets and tourist attractions
Can you please indicate what other features you find useful?
Evaluate, regarding its usefulness in a mobile ticket application for public transport oriented to tourism, the following information about public transport:
Network map
Means of transport available
Network tariff
Trip cost
Ticket validation instructions
Ticket purchase instructions
Travel time
Schedules
Waiting time until the next trip
Journey path
Transport frequency
Vehicle occupation
Ticket office location and schedule
Conditions of use for children
Operator contacts (helpline or others)
Accessibility conditions for people with reduced mobility
Conditions of use for pets
Can you please indicate what other information on public transport do you consider relevant?
Evaluate, regarding its usefulness in a mobile ticketing application for public transport oriented to tourism, the following information about tourist attractions:
Tourist attraction locations
Description of tourist attractions
Photos of tourist attractions
Tourist attractions' price
Tourist attractions' schedule

Table A1. *Cont.*

Sociodemographic Characterization
The popularity of tourist attractions Can you please indicate what other information about tourist attractions do you consider relevant?
Public transport in a tourist context during a global pandemic
Assess the following information on public transport for its usefulness in the context of a global pandemic: (Possible answers: very useless; useless; neither useful nor useless; useful; very useful) The capacity of public transport Disinfection of public transport Location of hydroalcoholic solution dispensers Specific rules for the use of public transport Number of confirmed cases in the city Alerts and notifications from local health authorities Hospital locations Evaluate the following statement: (Possible answers: totally disagree; disagree; neither agree nor disagree; agree; totally agree) When traveling, a mobile ticketing application can help me be better protected from the risks associated with a global pandemic. Do you want to indicate how the mobile application would help you to protect yourself?

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