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Mobile payments adoption in public transport

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Abstract

Nowadays, mobile phones are ubiquitous systems of our society. Nevertheless, the adoption of this technology to perform mobile payments, namely in public transport, was only implemented in a few number of transport networks. Thus, this paper aims to understand which are the main factors that may influence the adoption of mobile payments in public transport. For this purpose, a survey was applied to different groups of population. The study was conducted on the public transport networks of a medium-sized metropolitan area (Oporto-Portugal) and of a big-sized metropolitan area (Beijing-China). The evaluation results of the current services of purchase and validation of public transport tickets almost never show significant statistical differences ($p>0.05$) for the traditional variables used by the literature. This is particularly true for age. Nevertheless, some mobility factors can sometimes play an important role in the assessment of ticketing systems. Moreover, although the high differences between the ticketing systems in both cities, Chinese and Portuguese have a similar opinion about the systems implemented in their cities. Still, Chinese reveal a higher motivation to adopt the new ticketing system. In general, such system is greatly accepted by the respondents and the potential market is expected to be high (30-68%). Although this technology cannot replace the traditional systems, it can contribute to increasing the overall efficiency of the transport networks. The improvement of the passengers' appraisal, the reduction of operational and the maintenance costs of transport operators are the network impacts most expected. Convenience and time saving are the main advantages mentioned while questions about privacy, interaction and reliability are stated as the main concerns to adopt it.

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1. Introduction

Nowadays, mobile phones are ubiquitous systems of our society. In several activity sectors the use of mobile phones can be used to revolutionize their services. The public transport sector is not an exception. Here such technology can change the current service delivery process and its value proposition (Campos Ferreira et al. 2012). Public transport providers may offer new services to their customers through a single channel. This not only changes the overall travelling experience, since travelers could access to real-time information, maps, timetables, share opinions and pay for their trips, but also changes the way of how providers manage their resources. For both stakeholders great operational gains are expected (Campos Ferreira et al. 2012).

In order to implement such technologies, in the recent years several studies have analyzed the potentialities of mobile technologies, such as Wi-Fi, QR Codes, NFC and BLE (Jose et al. 2013; Campos Ferreira et al. 2014a; Leal et

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al. 2015). Based on these technologies, several researchers have proposed ticketing solutions for specific regions (Campos Ferreira et al. 2014b, Rodrigues et al. 2014; Campos Ferreira and Dias, 2015). The adoption of these solutions has been analyzed for different public transport modes (Brakewood et al. 2014, Cheng & Huang, 2013; Mallat et al. 2008). However, although some cities, such as Bordeaux, implemented mobile ticketing solutions on their public transport network, the adoption of such technologies seems to achieve limited success (Dahlberg et al., 2015; Thakur and Srivastava, 2014).

In order to better understand this problem, several researchers have studied the key factors that influence the adoption of mobile payments in public transport. Mallat et al. (2008) identified eleven determinants related to the technology adoption, namely: ease of use, usefulness, attitude, social influence, compatibility, cost, prior experience, trust, risk, use context and mobility. Other studies corroborate some of these findings. The cost (Wu and Wang 2005; Dahlberg et al. 2008), the loss of privacy (Bauer et al. 2005) and the perceived risk and trust (Siau et al. 2004; Mallat 2007; Ghosh and Swaminatha 2001) have been the most analyzed factors. Some authors also highlight that the usability problems are responsible for the low adoption of a variety of payment system (Laukkanen and Lauronen 2005; Szmigin and Bourne 1999).

Based on these studies, several models have been proposed to better understand the key factors which can affect the adoption of this system. Brakewood et al. (2014) used a binary logit model to forecast the adoption of mobile payments on the entire rail network of Boston area, while Di Pietro et al. (2015) proposed a model which was designed specifically for mobile payments in the public transport.

The most used socio-economic variables in the previous studies are gender and age (Cheng and Huang, 2013; Di Pietro et al. 2015). Di Pietro et al. (2015) also studied the influence of experience and voluntariness, while Mallat et al. (2009) analyzed the impact of the region and the experience on mobile ticket usage. Educational attainment, monthly income and occupation were other variables included in some studies (e.g. Cheng and Huang, 2013). Nevertheless, to the authors' best knowledge, the mobility factors, as the travel mode or frequency, seem to be not frequently included in these analyses. Moreover, although several factors which influence the adoption of mobile payments in public transport were identified, a comparative study between different groups of travelers and different cities is missing. Thus, the present study was conducted in order to understand such differences. The main research questions of this study are:

- Are the factors which influence the adoption of mobile payments in public transport, usually identified by the literature, significantly different among the various groups of travelers? Have the mobility factors an important role in the adoption of such system? Is the observed pattern recorded across different cities?
- What is the maximum probability of traveler's to adopt ticketing mobile solutions in public transport?

In order to answer these questions a survey was applied to some groups of travelers. To quantify the potentialities of the market, the use of smartphones during public transport trips was estimated. The study was conducted both in a medium-sized metropolitan area (Oporto-Portugal) and in a big-sized metropolitan area (Beijing, China).

The paper is structured as follow: section 2 outlines the methodology used. The most important results are presented and discussed in section 3. The conclusions and answers to the previous questions are given in section 4.

2. Data and methods

2.1 Study area

The study was conducted in two metropolitan networks of public transport: in Oporto's, a medium-sized network (Portugal), and in Beijing's, a big-sized network (China).

The public transport network of the Metropolitan Area of Oporto serves 1.75 million of inhabitants. This network is composed of 126 buses lines (urban and regional), 6 metro lines, 1 cable line, 3 tram lines and 3 rail lines. This system is operated by 11 transport providers, from which *Metro do Porto* and STCP are the largest (TIP, 2014). In contrast, the public transport network of the Metropolitan Area of Beijing serves 21.52 million of inhabitants. The network is composed of 1,020 buses lines (including rapid bus lines, evening bus lines and suburban bus lines), 18 metro lines and one suburban railway line. This system is operated and managed by various transportation operation companies, including Beijing Public Transit Holdings, Beijing Subway Operation Company and Beijing Railway Bureau.

In Oporto, the public transport network is based in an open and intermodal zonal system. A rechargeable intermodal smartcard called Andante is used for trip payments. There are three types of Andante transport tickets: (i) Signature Titles, (ii) Occasional Titles and (iii) Andante 24. The Signature Titles have different groups of users where the monthly charge depends on the traveler age or economic conditions. Such cards are valid for a set of adjacent areas previously chosen by the passenger and it is valid only for the charged month. On the other hand, Occasional Titles are valid in a set of zones that include rings around the area where the customer has initiated the trip (1st validation location). In this type of card, the ticket is valid within the limit ring acquired during a particular time period, currently 1 hour for the minimum 2-zone ticket, and longer as the number of valid zones increases. Thus, one journey may have one or more stages (validations), depending the time period of the journey and the number of zones included in that journey. Finally, with the Andante 24 the travelers can use all the network during 24 hours after the first validation.

In Beijing, the public transport network is based in a closed system. A rechargeable intermodal smart card called Yikatong is used for trip payments. This card can be used in metro lines, bus lines, suburban railway lines, taxis and parking. The card can also be used to perform payments in some restaurants, gyms, theaters, groceries, bookstores, drugstores and public phones (Yikatong, 2015). There are two types of transport tickets: (i) Adult Cards and (ii) Student Cards. Student cards are provided for students who register in primary schools, middle schools, high schools and universities in Beijing. Since December 28th, 2014, Beijing started to use a new pricing scheme for transit users, in which metro passengers are charged according to the number of kilometers travelled. Yikatong also provides a discount to frequent metro passengers based on their travelling monthly expenses. Such discount varies between 20% and 50% and is only applied for users which have a monthly cost of travelling ranging between 100 RMB and 400 RMB. When such cost is higher than 400 RMB, the users do not have any discount. In buses, passengers with adult card users have 50% discount on their trips while passengers with student card users have 75% discount (Bao, 2014).

2.2 Methods

To identify the key factors related with the adoption of mobile payments in public transport, a web-based survey was applied to travelers of both public transport networks on study. Such survey was structured as follows: (a) sample characterization; (b) mobility characterization; and (c) evaluation of the ticketing systems, purchase and validation, using the traditional systems and the mobile phones. The evaluation of the services was done according to the five-point Likert scale (Matell and Jacoby, 1972) ranging from strongly disagree to strongly agree.

Data were collected for different groups of travelers (s, e and u). For each traveler was identified the gender (G_m and G_f), age (Y_1, Y_2, Y_3 and Y_4), qualifications (Q_h, Q_b, Q_m and Q_p) and experience in using the smartphone (S_n, S_l, S_b and S_m). To characterize the mobility the typical travel mode used (F_m, F_b, F_t, F_y and F_2), the travel mean frequency (A_d, A_f, A_o and A_r), the hurry (H_y and H_n), the typical ticket type used (K_c, K_m and K_o) and the typical place to purchase the tickets (P_v, P_p, P_s, P_i and P_o) were collected.

In Oporto (O) the survey was distributed to different groups of travelers (R), namely students (s), employees (e) and unemployed (u) people ($N_{O,s}$=270, $N_{O,e}$=119, $N_{O,u}$=11). These groups were defined taking into account the main ticketing categories of signature titles available in Oporto. Although in Oporto we had a large number of volunteers to fill the survey, in Beijing (B) the condition was different. Besides constraints in the survey conduction, the acceptance of the potential respondents in Beijing is low. Due to these limitations the survey was only applied to the group of students ($N_{B,s}$=44). Table 1 shows a description of each variable for both metropolitan areas.

Table 1. Sample characterization.

	Variables		Acronym	Oporto				Beijing
				All (%)	*s (%)*	*e (%)*	*u (%)*	*s (%)*
	Sample		N		270	119	11	44
Sample characterization	Gender (G)	Female	G_f	48.5	**55.9**	34.5	18.2	45.5
		Male	G_m	**51.5**	44.1	**65.5**	**81.8**	**54.5**
	Age (Y)	<=21	Y_1	**44.9**	**64.2**	1.9	0.0	**81.8**
		22-31	Y_2	37.9	33.2	**46.7**	**63.6**	18.2
		32-41	Y_3	9.7	1.9	27.1	27.3	-
		>=42	Y_4	7.6	0.8	24.3	9.1	-
	Qualifications (Q)	High school	Q_h	30.3	**42.6**	5.0	0.0	**84.1**
		Bachelor	Q_b	**33.0**	40.0	17.6	27.3	13.6
		Master	Q_m	29.8	16.3	**57.1**	**63.6**	2.3
		PhD	Q_p	7.0	1.1	20.2	9.1	0.0

Mobility characterization	Use of smarthphone (*S*)	Do not have	S_n	7.5	8.1	4.2	27.3	0.0
		Less than 6 month	S_l	4.5	5.2	3.4	0.0	0.0
		Between 6 month and 2 years	S_b	26.0	27.0	24.4	18.2	0.0
		More than 2 years	S_m	**62.0**	**59.6**	**68.1**	**54.5**	**100**
	Transport modes (*F*)	Metro	F_m	21.5	18.1	28.6	27.3	25.0
		Bus	F_b	15.5	17.8	10.9	9.1	0.0
		Train	F_t	2.0	0.7	5.0	0.0	0.0
		Bicycles	F_y	-	-	-	-	15.9
		More than one mode	F_2	**61.0**	**63.3**	**55.5**	**63.7**	**59.1**
	Mean frequency of use (*A*)	Daily (on average 1 trip / day)	A_d	**63.2**	**73.7**	**41.2**	**45.5**	2.3
		Frequently (on average 1 trip / week)	A_f	21.5	18.9	26.1	36.4	**72.7**
		Other	A_o	15.3	7.4	32.8	18.2	25.0
	Hurry when arrive at public transport stops (yes / no) (*H*)		H_y	**77.8**	**76.7**	**83.2**	45.5	31.8
			H_n	22.3	23.3	16.8	**54.5**	**68.2**
	Ticket types (*K*)	Occasional titles	K_c	37.3	27.8	**56.3**	**63.6**	-
		Monthly card	K_m	**57.0**	**67.4**	36.1	27.3	-
		Normal card	K_x	-	-	-	-	**68.2**
		Other	K_o	5.7	4.9	7.4	9.1	31.8
	Places to buy tickets (*P*)	Vending machines	P_v	**59.8**	**60.0**	**59.7**	**54.5**	**54.5**
		Payshop and CTT agents	P_p	16.8	20.0	7.6	36.4	-
		Shop Customer Service	P_s	14.8	14.4	16.0	9.1	27.3
		Inside the vehicle	P_i	3.5	4.4	1.7	0.0	11.4
		Others	P_o	5.1	1.1	15.0	0.0	6.8

bold: answers with a higher percentage.

To compare the different groups and public transport networks on study two main steps were followed: (i) first, the main categories for each service were defined; and then (ii) the statistical differences were checked.

In the first step, a factorial analysis was applied in order to establish the main categories for each service. This analysis was based on the variables' weights in each factor. In this study, if the weights did not allow identifying categories, a varimax rotation was considered. Varimax rotation is an orthogonal rotation method that intends, for each principal component, to only have a few significant weights, and all the others near to zero (Abdi, 2003). The main aim is to maximize the variance of the weights of each principal component. In this analysis four classes were defined to access the traditional system: (T_i) implementation of new services (e.g. historic access of data, time left for a travel); (T_{ii}) lost travel card; (T_{iii}) ease of use the system; and (T_{iv}) dislike the system. Regarding the new system, three classes were defined to assess the purchasing system of travel cards ((P_i) intention of use, (P_{ii}) reliability; and (P_{iii}) risk) and another three classes for the validation system ((V_i) reliability; (V_{ii}) no usefulness and/or compatibility; and (V_{iii}) no risk).

The normality of each category was tested using the Kolmogorov-Smirnov test. This test showed the non-normal distribution for almost all variables. Thus, in order to test for significant differences in central tendency parameters, non-parametric tests (Mann-Whitney and Kruskal-Wallis) were used. Mann-Whitney test was applied to identify the particular significant differences between two sub-groups (e.g. G_f and G_m) while Kruskal-Wallis test was used to detect significant differences between three or more sub-groups (e.g. K_c, K_m and K_o).

Finally, to quantify the maximum probability to adopt the new ticketing system in public transport, the percentage of smartphone users was quantified during random periods of one minute along two weeks of January 2016 (N_O=35, N_B=35). For this purpose, random points were selected in both public transport networks. The tests were performed in different day periods, transport modes, lines and providers. In this analysis we considered a smartphone user whenever a traveler is interacting with their smartphone, either passively or actively. This means that for a traveler being considered a potential user, in the moment of the counting, he just need to have the phone in their hands (passive use).

3. Results

3.1 Sample characterization

The demographic and mobility profiles of the respondents are presented in Table 1.

In Oporto more than 50% of the respondents are male (51.5%). The majority have less than 32 years old (82.8%), a university degree (79.8%) and a smartphone at more than two years (62.0%). During their trips typically they use a monthly card (57.0%) purchased/recharged in vending machines (59.8%). They use more than one travel mode

(61.0%), daily (63.2%) and commonly they catch it with a hurry (77.8%). A comparison between the groups analyzed (*s*, *e* and *u*) highlight some differences. Those differences are particular high regarding gender (*G*), qualifications (*Q*) and type of tickets used to travel (*T*).

In Beijing the condition is a little bit different than the observed in Oporto. The majority of the respondents (students) have less than 22 years old (81.8%) and only has the high school (84.1%). All of them have a smartphone for more than two years. As opposite to what happens with the students of Oporto, in Beijing the students typically use only once a week the public transport (72.7%). This occurs since in this megacity the students usually live inside the university campus. Nevertheless, bicycles are very popular (15.9%). During these trips typically they do not arrive at the public transport stops in a hurry (68.2%). As happens in Oporto, vending machines are the most popular way to purchase and recharge the travel cards (54.5%).

3.2 Evaluation of the services

The evaluation of the current system of purchase and validate travel tickets, available in the city of Oporto, showed that in general there are no significant statistical difference ($p>0.05$) between the sub-groups of the traditional variables (*G*, *Y, Q* and *S*) and the classes previously defined (T_i, T_{ii}, T_{iii} and T_{iv}). The same pattern was observed for the majority of mobility variables (*F*, *A*, *H*, *K* and *P*). The exceptions found were between T_i and *R* ($p=0.040$), T_i and *S* ($p=0.026$), and T_{iii} and *G* ($p=0.018$). For the new ticketing system a similar pattern was observed. While for the purchasing system, significant statistical differences were found between P_{ii} and *F* ($p=0.029$), and P_{iii} and *Q* ($p=0.009$), for the validation system statistical differences were only found between V_{ii} and *Q* ($p=0.030$).

Regarding the comparison between both Metropolitan Areas, Table 2 shows the evaluation results of the purchase and validation of travel tickets using (i) the traditional systems and (ii) the mobile phones. The results are presented for the sub-group of student (*s*) for Oporto and Beijing and by occupation type (*s*), gender (G_m and G_f), age (Y_1 and $Y_2+Y_3+Y_4$), qualifications (Q_h and $Q_b+Q_m+Q_p$), experience in use smartphone (S_m and $S_n+S_l+S_b$), transport modes of public transport ($F_m+F_t+F_b+F_y$ and F_2), mean frequency of use public transport (A_d and $A_f+A_o+A_r$), hurry in catch public transport (H_y and H_n), travel ticket types (K_m or K_x and K_o) and places to buy travel tickets (P_y and $P_n+P_s+P_i+P_o$). For this analysis, new sub-groups were created in order to avoid classes with frequencies very different and thus ensure a good reliability of the applied tests.

The comparison of the actual system of purchase and validation of travel tickets between both Metropolitan Areas reveals that Portuguese and Chinese students have a similar opinion about the public transport system of their cities. The absence of access to the travel history (T_i) and the ease of use this system (T_{iv}) are the categories identified as most relevant for users. Moreover, although the differences in the sample distribution (see Table 1), the general opinion of the respondents does not change between each analyzed sub-group. In Oporto high significant differences were found between T_i and *S* ($p=0.021$), T_{iii} and *G* ($p=0.010$) and T_{iii} and *P* ($p=0.035$). In Beijing high significant differences were found between T_i and *G* ($p=0.043$), T_i and *H* ($p=0.033$), T_{ii} and *K* ($p=0.018$), T_{iii} and *A* ($p=0.020$), T_{iv} and *Q* ($p=0.049$) and T_{iv} and *K* ($p=0.078$). These results are very interesting since the systems implemented in these two cities are very different from each other. In Oporto, the network is based in an open and intermodal zonal system where there are available several types of tickets, including a monthly pass. In Beijing, the network is based in a closed system with a non-intermodal policy pricing. In this city, although there are no monthly passes, a pricing policy based on discounts is provided for the most frequent travelers.

Regarding the new system of purchase and validation tickets using the mobile phone, we found that in general this system is greatly accepted by the respondents. The evaluation of this service follows the same trend as observed previously for the actual ticketing system. However, Chinese students show a higher motivation to adopt this new system than Portuguese. This result can be related with the difference between the degree of use of mobile phones in both cities. While in Oporto the average value of smartphone usage is 30±12%, in Beijing this value is twice higher (68±10%). Nevertheless, in this study we only quantified the passive and active users. This means that the smartphones owners should be much higher in both study areas and therefore the levels of the market to introduce such technology.

Regarding the implementation of the new ticketing system, convenience and time saving are the main advantages mentioned by the respondents. Nonetheless, several questions about privacy, failure battery, and mobile phone network are mentioned as the main concerns to adopt it. In Oporto, older people also highlight some worries related to the mobile phone interaction due to small characters and the usually high amount of information in these applications. However, a high percentage of the respondents is interested in different types of services such as receive

information about the stop to which is possible travel with the current ticket, know how much time is left to travel after validate the ticket, or know how much is spent per month on public transport.

For these new services, high statistical significance was found between different sub-groups of students (Table 2). In Oporto high significant differences were found between gender (*G*) and P_{ii} (p=0.014), P_{iii} (p=0.048), V_i (p=0.045) and V_{ii} (p=0.020). In this city, high statistical significant differences were also found between P_{ii} and *F* (p=0.039) and P_{iii} and *Q* (p=0.014). In Beijing, significant differences were found between P_i and *A* (p=0.020), P_i and *H* (p=0.011), V_i and *K* (p=0.004), and V_{ii} and *K* (p=0.003). This highlight that besides gender (*G*) and qualifications (*Q*) several mobility's factors as the typical travel mode (*A*), travel mean frequency (*F*) and hurry (*H*) could also play and important role in the implementation of these new services.

4. Conclusions

In this work the profile of different groups of travelers was assessed across different cities in order to identify the main factors that influence the adoption of mobile payments in public transport. For this purpose, a survey was applied and the potential market penetration of this technology was assessed. The study was conducted on the public transport networks of a medium-sized (Oporto-Portugal) and of a big-sized (Beijing-China) metropolitan area.

In Oporto, the evaluation results of the current services of purchase and validate of travel tickets do not show significant statistical differences (p>0.05) for the traditional variables identified by the literature (*G, Y, Q* and *S*). This is true between the different groups analyzed (*s*, *e* and *u*). Mobility factors as the mean travel frequency (*F*) seems to affect these groups' of travelers but only in the assessment of the new ticketing system.

The comparison between both metropolitan areas allows to conclude that besides mean travel frequency (*F*), other mobility factors as average travel frequency (*A*), hurry (*H*), traditional places used to buy tickets (*P*) and the typical type of ticket used (*K*) can also have an important role in the assessment of ticketing systems. Although some differences between the current ticketing systems available in these cities, the opinion of respondents is very similar. Still, Chinese students demonstrate a higher motivation to adopt the new ticketing system. In general, there is great acceptance in the use of the mobile payments in public transports and the levels of market are high. In Beijing the maximum probability of traveler's adopt this solution is twice higher than in Oporto (*P*: 30%; *B*: 68 %). Convenience and time saving are the main advantages mentioned by respondents. Questions about privacy, interaction and reliability are mentioned as the main concerns to adopt it.

Table 2. Average classification (1-5) of the aspects of the services of purchase and validation of public transport tickets using the (i) traditional systems and (ii) mobile phones. The results are presented for Oporto and Beijing Metropolitan Areas for the sub-group of students.

Local	*Categories*		*General variables*									*Mobility variables*									
			Ocupa-cion.	*Gender*		*Age*		*Qualifica-tions*		*Experience using the smartphone*		*Transport modes*		*Mean frequency*		*Hurry*		*Ticket types*		*Places to buy tickets*	
			s	G_m	G_f	Y_1	$Y_2+Y_3+Y_4$	Q_h	$Q_b+Q_m+Q_p$	S_m	$S_n+S_l+S_b$	$F_m+F_t+F_b+F_y$	F_2	A_d	$A_f+A_o+A_r$	H_y	H_n	K_m or K_x	K_o	P_v	$P_p+P_s+P_t+P_o$
Oporto	Actual system	New services (T_i)	3.91	3.96	3.87	3.92	3.90	3.93	3.89	3.98	3.79	3.98	3.87	3.94	3.83	3.88	3.99	3.92	3.87	3.89	3.93
		Lost travel card (T_{ii})	1.79	1.74	1.82	1.76	1.82	1.73	1.83	1.80	1.77	1.69	1.84	1.76	1.86	1.83	1.65	1.77	1.81	1.80	1.76
		Ease of use (T_{iii})	3.95	3.84	4.04	3.94	3.98	3.93	3.97	3.94	3.96	3.92	3.97	3.95	3.96	3.96	3.94	3.95	3.97	3.87	4.07
		Dislike (T_{iv})	3.35	3.37	3.34	3.33	3.44	3.35	3.35	3.42	3.25	3.46	3.29	3.33	3.42	3.36	3.34	3.33	3.39	3.41	3.26
	New Purchase system	Intent to use (P_i)	3.72	3.78	3.66	3.71	3.74	3.68	3.74	3.71	3.72	3.82	3.66	3.69	3.78	3.70	3.77	3.67	3.81	3.76	3.65
		Reliability (P_{ii})	3.19	3.33	3.07	3.15	3.27	3.20	3.17	3.24	3.10	3.33	3.10	3.18	3.19	3.17	3.23	3.15	3.25	3.21	3.15
		Risk (P_{iii})	2.92	2.82	3.00	2.85	3.05	2.80	3.02	2.96	2.87	2.82	2.99	2.93	2.93	2.92	2.95	2.91	2.95	2.94	2.90
	New Validation system	Reliability (V_i)	3.63	3.73	3.56	3.64	3.62	3.67	3.60	3.63	3.64	3.67	3.61	3.62	3.67	3.65	2.59	3.63	3.64	3.68	3.56
		No useful/comp. (V_{ii})	2.61	2.50	2.69	2.61	2.58	2.53	2.66	2.57	2.65	2.58	2.62	2.64	2.51	2.62	2.55	2.63	2.54	2.60	2.61
		No risk (V_{iii})	2.86	2.87	2.86	2.89	2.83	2.91	2.81	2.85	2.88	2.93	2.82	2.89	2.79	2.87	2.83	2.90	2.80	2.83	2.91
Beijing	Actual system	New services (T_i)	3.48	3.75	3.26	3.49	3.45	3.54	3.20	3.48	-	3.47	3.49	3.49	3.47	3.87	3.30	3.48	3.48	3.45	3.52
		Lost travel card (T_{ii})	1.88	1.83	1.92	1.89	1.81	1.95	1.50	1.88	-	1.78	1.94	1.91	1.79	2.00	1.81	1.71	2.27	1.98	1.75
		Ease of use (T_{iii})	3.89	3.98	3.81	3.86	4.00	3.84	4.14	3.89	-	3.78	3.96	4.09	3.33	3.96	3.85	3.88	3.88	3.81	3.98
		Dislike (T_{iv})	3.19	3.40	3.02	3.28	2.81	3.32	2.50	3.19	-	3.56	2.94	3.11	3.42	3.14	3.22	3.00	3.65	3.00	3.43
	New Purchase system	Intent to use (P_i)	3.86	3.95	3.78	3.79	4.15	3.78	4.29	3.86	-	3.92	3.82	4.03	3.42	4.31	3.65	3.94	3.68	3.73	4.02
		Reliability (P_{ii})	3.60	3.80	3.43	3.54	3.88	3.53	3.95	3.60	-	3.72	3.51	3.72	3.28	3.71	3.54	3.57	3.67	3.44	3.78
		Risk (P_{iii})	2.64	2.93	2.39	2.67	2.50	2.73	2.14	2.64	-	2.28	2.88	2.54	2.89	2.40	2.74	2.51	2.95	2.53	2.77
	New Validation system	Reliability (V_i)	3.83	3.74	3.90	3.76	4.15	3.76	4.20	3.83	-	4.01	3.70	3.89	3.65	4.09	3.71	4.04	3.32	3.88	3.77
		No useful/comp. (V_{ii})	2.30	2.36	2.24	2.39	1.88	2.36	1.92	2.30	-	2.17	2.38	2.27	2.38	2.21	2.33	2.06	2.85	2.22	2.39
		No risk (V_{iii})	3.31	3.30	3.31	3.33	3.19	3.28	3.43	3.31	-	3.61	3.10	3.44	2.96	3.43	3.25	3.39	3.12	3.19	3.45

Underline value: sub-group with statistical differences ($p<0.05$); Answers: ≥1.50 | 1.51- 2.50 | 2.51-3.50 | 3.51-4.50 | ≤4.51

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