Intention of BTS Skytrain Passengers to Use QR Ticket for Metro Mass Transit System in Bangkok

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Abstract

Bangkok Metro passengers still have to queue at metro stations to buy, recharge and use their card tickets. Passengers have to spend time and effort waiting when it is crowded. This study aims to provide a new QR code ticketing system for the Bangkok Metro mass transit system and to understand passengers' intention to use it. The study used a design science research approach and used a mixture of quantitative and qualitative research methods. The study sample was BTS Skytrain passengers because BTS is the first metro system in Thailand. In this study, 176 questionnaires were collected through a questionnaire survey and a prototype of a QR ticket was designed by analyzing passenger needs and document analysis. Finally, 175 questionnaires were analyzed to derive the evaluation and usage intention of QR tickets. It was found that most passengers prefer card tickets, but passengers with higher education levels are more likely to accept QR tickets. The demand for QR tickets is trust and efficiency. Passengers rated the newly designed QR tickets highly, and the perceived ease of use and perceived usefulness of the tickets influenced passengers' intention to use them.

Keywords : Technology Acceptance Mod, E-payment, Mobile App, QR Codes ticket, Metro

2. Introduction

Nowadays, electronic payments are growing rapidly under the influence of COVID-19, and 76% of adults worldwide already use electronic payments, which have become the most popular non-cash means of payment worldwide (World Bank, 2022). Electronic payment methods such as card tickets (contactless smart cards), cardless tickets (NFC payments, and QR code payments), are also starting to gain popularity in metro systems. According to the Mpaypass report (2019), China has taken the lead in using cardless tickets in public transportation, with 94.1% NFC coverage and 88.2% QR code coverage in 34 cities with metros. Meanwhile, Thailand, as a major e-payment country, has a large e-payment user base, with 9.7 billion e-payment transactions in 2021 and the third highest e-payment usage rate in the world, behind China (Leesa-Nguansuk, 2022).

According to the official websites of BTS (2022) and MRT (2022), the main mode of travel in the Bangkok metro mass transit system is still card-based tickets such as single journey tickets and stored value cards (SVC). This poses some problems when stations are crowded and it is difficult for passengers to purchase and recharge their tickets, which takes a lot of time and effort to queue and makes them unsatisfied (Poomrittigul et al., 2019). This problem can be solved by the QR code ticket, which is a cardless ticket where passengers no longer need to spend time and effort to queue to buy or recharge their tickets. Simply move your finger on the mobile app to complete the ticket purchase and enter the station by scanning the QR code. From the Mpaypass report (2019), China has already used QR code tickets in its metro mass transit system, while Thailand's metro mass transit system has yet to start using them.

In the case of passengers in Thailand who are not yet aware of this new ticket, passengers will QR ticket use keep a wait-and-see attitude. Because passengers only use electronic payment methods that will suit their specific needs (Kaewratsameekul, 2018), it is valuable to study the needs of passengers of the Bangkok metro mass transit system and their intention to use QR tickets.

2. Objective

1. To understand the needs of passengers of the Bangkok Metro Mass Transit System pertaining to ticket payment.
2. To propose a new system that allows passengers to use the QR tickets in the Bangkok Metro Mass Transit System.
3. To study passengers' intentions to use the QR tickets in the Bangkok Metro Mass Transit System.

3. Literature review

Metro Mass Transit System

Metro Mass Transit System is a rapid transit system that provides for the uninterrupted operation of metro trains on railroads, tunnels or on viaducts. (Fraszczyk, 2014). The world's first metro system opened in 1863 in London, UK (Rimmer, 2013), and the first metro system in China opened in 1969 in Beijing (Duan et al., 2020). The first metro system in Thailand, the BTS, opened in Bangkok in 1999 (Anantsuksomsri et al., 2015).

Today, Automated Fare Collection Systems (AFC) are widely used in metro mass transit systems (Ferreira et al., 2017). Passengers place their tickets on the Automated Fare Collection Systems (AFC) machine's recognition area. After successful recognition, the AFC gates automatically open so that passengers can enter the station (Chandra et al.,2013) Electronic payment methods can be divided into three main categories: 1) smart cards 2) QR code tickets purchased by cell phones 3) contactless tickets simulated by cell phones through NFC technology (Bartin et al., 2018). Among them, QR tickets and NFC are the classic cardless tickets.

E-Payment

Electronic payment is a type of non-cash payment done through the Internet in the context of e-commerce (Hascaryani ,2013; Kaur et al. 2015; Hidayanto et al. 2015).

It has been shown (Fonchamnyo, 2013; Sciarelli et al., 2021) that the following five e-payment characteristics may influence the Technology Acceptance Model (TAM), which are trust, efficiency, reliability, security, and usability (ease of use). Trust refers to the level of user trust in the e-payment system (Hidayanto, 2015; Kumar, 2019); efficiency refers to the time and cost savings that can users (Lai and Lim, 2019); reliability refers to the stability and reliability of the system (Hidayanto et al., 2015); security refers to the system's ability to defend against Internet attacks and can protect users' information and privacy without losing their money (Abrazhevich, 2004; Tsiakis and Sthephanides, 2005; Hidayanto et al., 2015); usability (ease of use) means that users can use electronic payments very easily (Hidayanto et al., 2015; Shao et al., 2019).

There are five common types of electronic payments as follows: 1) credit cards, a plastic card with a unique digital account and an embedded magnetic disk that allows prepayment (Bezovski, 2016; Chen et al., 2019); 2) debit cards, similar to credit cards, where the user makes a transaction through a bank account and the amount is automatically deducted from the card's bank account (Chen et al., 2019); 3) Smart cards, commonly used in

transportation payments, which can store funds that will be deducted after payment (Prayoonphan, 2019; Thangamuthu, 2020); 4) Mobile banking, an application provided by banks on which users can perform the corresponding financial services (Shaikh and Karjaluoto, 2015; Tam and Oliveira, 2017); 5) Mobile wallet, a digital account that integrates both the user's funds and cards into the mobile software, allowing the phone to be used as a wallet (Uddin and Akhi,2014;Mahapatra and Patra, 2016).

Technology Acceptance Model

The technology acceptance model, proposed by Davis, has two determinants, perceived ease of use and perceived usefulness. Perceived usefulness refers to the user's perception that using a system or technology will help him or her improve performance and Perceived ease of use means that a person is effortless to use the new technology. (Cho and Sagynov, 2015). Previous studies have shown that factors affecting perceived usefulness include trust, efficiency, reliability, and security (Kaewratsameekul, 2018; Sciarelli et al. 2021; Chi, 2018; Liu et al. 2022). Perceived ease of use refers to the user's perception that using a system or technology is not mentally or physically taxing, and previous research has shown that usability, also called ease of use, is an important factor influencing perceived ease of use (Pei et al., 2015; Nourallah, 2020).

Demographic Characteristics

Research has shown that three demographic characteristics - gender, education level and occupation - affect user acceptance. Gender differences have a significant impact on the intention to use mobile payments (Lwoga and Lwoga, 2017), people with higher education are more likely to accept the use of electronic payments in public transportation (Fontes et al., 2017), and students are the largest group of mobile payment users and more willing to use electronic payments (Tarigan et al., 2022).

4. Theoretical framework & research questions

Theoretical framework

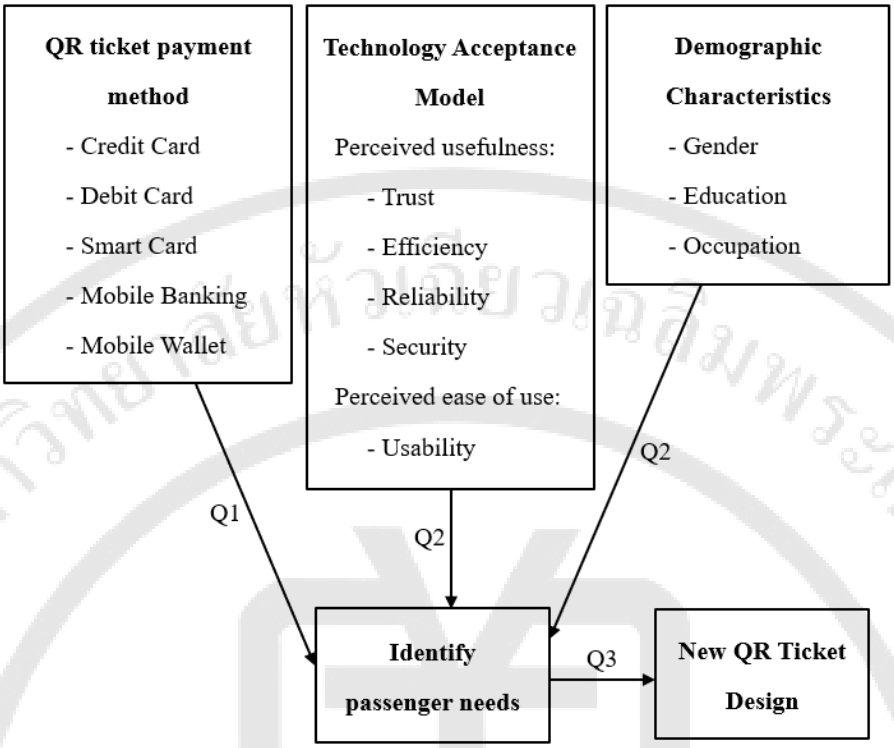

Figure 1 Theoretical framework

Research questions

1. What are the needs of passengers of the Bangkok Metro Mass Transit System pertaining to the payment of tickets?
2. What would be the physical feature and appearance of tickets based on a new system that allows passengers of the Bangkok Metro Mass Transit System to use the QR code?
3. What is the degree of willingness on the part of passengers of the Bangkok Metro Mass Transit System in regard to the use of the QR tickets?

5. Research methodology

This study used a mixed research method combining qualitative and quantitative methods. The qualitative method was document analysis. The quantitative method was a questionnaire survey. The type of research was designed for scientific research. The sample for this study was BTS Skytrain passengers. Because of the large population size and the unknown when determining the sample size, the Cochran formula was used: $n=Z^2pq/e^2$ (Chaokromthong and Sintao, 2021). The average daily ridership of the BTS light rail is found to be 12.5% of the population of Bangkok (Egis, 2022), assuming a confidence level of 95% (marginal error of 0.05). ($n=0.125*(1-0.125)*(1.96)^2/(0.05)^2=168$), yielding a minimum sample size of 168. There were two questionnaires in this study, the demand questionnaire received 176 and the evaluation questionnaire received 175 valid questionnaires. The reliability of all scales in this study was greater than 0.7 and passed the test.

Table 1 Scale Reliability

Scale	Cronbach's Alpha	N of Items
Perceived usability	0.987	176
Perceived ease of use	0.960	176
Perceptual usefulness evaluation	0.940	175
Perceptual ease of use evaluation	0.874	175
Intention to use	0.922	175

6. Results

Passengers' e-payment need

The analysis of the quantitative data collected shows that BTS Skytrain passengers have the highest demand for mobile banking, followed by e-wallets and debit cards when riding the BTS Skytrain. Finally, smart cards and credit cards have the least demand, with the specific number of demands in Table 2.

Table 2 E-payment needs

Item	N	Percentage	Percentage of Cases
Credit Card	23	10.4	13.1
Debit Card	33	14.9	18.8
Smart Card	24	10.9	13.6
Mobile Banking	101	45.7	57.4
E-Wallet	40	18.1	22.7
Total	221	100	125.6

Ticket Type

Analysis of the quantitative data shows (Table 3) that more BTS Skytrain passengers prefer card-based tickets than those who prefer cardless tickets. Also, the p-value of education by the chi-square test is 0.017, which is less than 0.05. It indicates that education affects passengers' ticket preferences, and the higher the education level of BTS Skytrain passengers, the more likely they are to accept cardless tickets, as detailed in Table 4.

Table 3 Ticket preference

Item	N	Percentage	Percentage of Cases
Card Ticket	113	59.8	64.2
Cardless Ticket	76	40.2	43.2
Total	189	100	107.4

Table 4 Education Level

Factor	Item	Ticket Type		Total	χ2	p
		Card Tickets	Cardless Tickets			
Education level	Under Bachelor degree	5	1	6	8.166	0.017
	Bachelor degree	79	41	120		
	Master's degree or higher	29	34	63		
Total		113	76	189		

Requirements of QR ticket

Table 5 clearly demonstrates the perceived usefulness needs of passengers for QR tickets. The overall mean of the scale is 3.37, so factors with a mean greater than 3.37 can be identified as influential. Trust and efficiency are the main influencing factors that affect passengers' perceived usefulness. These main influencing factors are in line with the findings of Alalwan et al. (2018); Sciarelli et al. (2021) that perceived usefulness is influenced by trust and efficiency. The specific factors that most passengers agreed on were ticketing technology, electronic payment providers, time-saving, no lag, fast response time, protection of personal information, and trusted security systems. These specific factors are consistent with the findings of previous researchers (Kaewratsameekul, 2018; Lai and Lim, 2019; Chi, 2018)

In short, passengers' needs for the usefulness of QR ticketing software are: the software should use a ticketing technology and electronic payment provider that passengers trust, QR ticketing software should save passengers' time, the software should be responsive and not lag, and finally, QR ticketing software needs to protect passengers' personal information and its security system is trusted.

Table 5 Requirements of perceived usefulness

Functions	Influence factors	Mean	Standard Deviation
Trust	e-payment provider	3.40	1.478
	ticketing technology	3.44	1.449
	metro company	3.33	1.440
Efficiency	saves time	3.41	1.059
	saves money	3.35	1.462
	not lag	3.41	1.391
Reliability	fast response time	3.41	1.459
	practical	3.30	1.456
	trouble-free	3.30	1.420

Functions	Influence factors	Mean	Standard Deviation
Security	protects personal information	3.38	1.460
	protects personal property	3.33	1.440
	trusted security system	3.38	1.507

According to Table 6, it can be seen that passengers demand QR ticketing software in terms of ease of use. The total mean of this scale is 3.38, so factors with a mean greater than 3.38 can be identified as influential. The main factor that influences the perceived ease of use of passengers is usability. These main factors are consistent with the definition of the International Organization for Standardization (2018) and the study of Nourallah (2020). The specific factor is the ease-of-use process, which is consistent with the findings of previous researchers (Teoh et al., 2013).

In short, the passenger's need for ease of use of QR ticketing software is that the process of using QR ticketing software must be easy and fast.

Table 6 Requirements of perceived ease of use

Functions	Influence factors	Mean	Standard Deviation
Usability	simple ticket interface	3.36	1.375
	user-friendly payment design	3.34	1.334
	convenient and fast process	3.45	1.401

Finally, a chi-square test shows that passengers' ticket choice preferences do not affect the perceived usefulness demand and the perceived ease of use demand for QR tickets, and passengers with both ticket preferences have the same demand for QR tickets.

Conceptual design

According to the data collected, passengers need a ticketing technology and electronic payment provider that is trusted, software that saves passengers' time, is responsive and does not lag, ticketing software that protects personal information and has a trusted security system, and ticketing software that is easy and fast to use. The QR code ticket used by Guangzhou Metro, on the other hand, has reduced the queues and the hassle in the ticketing process, effectively improving passengers' travel conditions (Tan, 2019). On the other hand, according to the report of 2C2P (2022), it can be seen that QR code payment is the second most popular electronic payment method in Thailand, trusted and accepted by Thai people. It can be concluded that the QR code ticket now used by Guangzhou Metro meets the needs of BTS Skytrain passengers.

QR Ticket uses QR code technology to allow passengers to enter and exit the station by scanning the QR code ticket, and the fare is automatically calculated and deducted automatically. The QR Ticket Software supports all major mobile banks, major e-banks, debit and credit cards, and allows you to choose the electronic payment option that suits your needs. The ticketing software also includes features such as payment history checking, ticket refresh, language switching, and instructions for use (Table 7).

Table 7 Conceptual design of function

Functions	**User requirements**	**Conceptual design**
Trust	e-payment provider	Choose e-payment method
	ticketing technology	QR Code Technology
Efficiency	saves time	Automatic deduction.
	not lag	Refresh
Reliability	fast response time	Large and clear QR code
Security	protects personal information	Social account sign-up and login.
	trusted security system	Payment History
Usability	convenient and fast process	Language Change
		Instructions for use

To use QR tickets, login or register with a social media account. The main ticket page has five elements: e-payment method selection, QR code ticket, ticket refresh, language switch and instructions for use. First-time users need to add and select the electronic payment method they want to use, and then they can use the QR code ticket. Users only need to align the QR code ticket with the scanning area of the subway gate, and after successful scanning, they can enter and exit the station, and the system will automatically complete the deduction when they leave the station. If there is a problem loading the 2D code ticket, the user can click the refresh button to reload the ticket. Passengers can also check their spending records. The software comes in Thai and English, so users can switch between them according to their needs. Figure 2 shows the flow chart of the ticketing software.

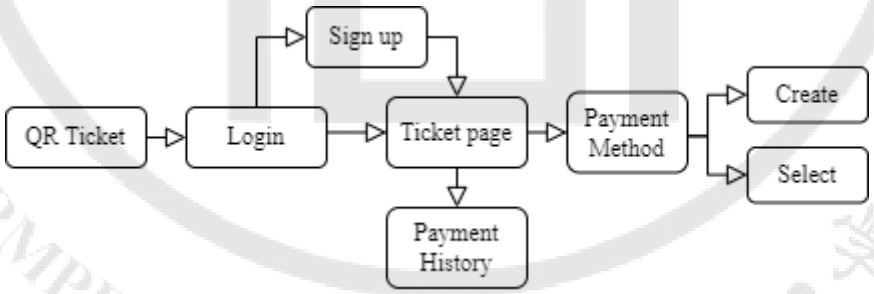

Figure 2 Flow chart

Prototyping

The QR ticket software prototype was designed based on the above concept, functions and flowchart. In order to ensure the simple and convenient design of the ticket application, the software should use a uniform color tone, and to ensure the success rate of QR ticket recognition, the area of the QR code should occupy a large enough proportion. In order to allow users to operate easily and quickly, the font of the buttons within the application should be simple and clear, and the buttons should be reasonably positioned and appropriately sized to allow users to perform one-handed operations. Figure 3 shows the wireframe draft of the ticketing application. Figure 4 shows the prototype of the ticket application.

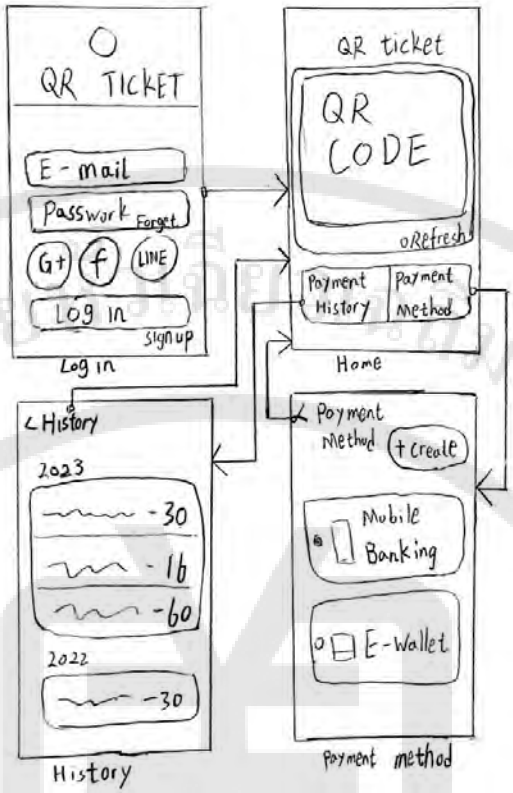

Figure 3 QR Ticket Software Wireframe

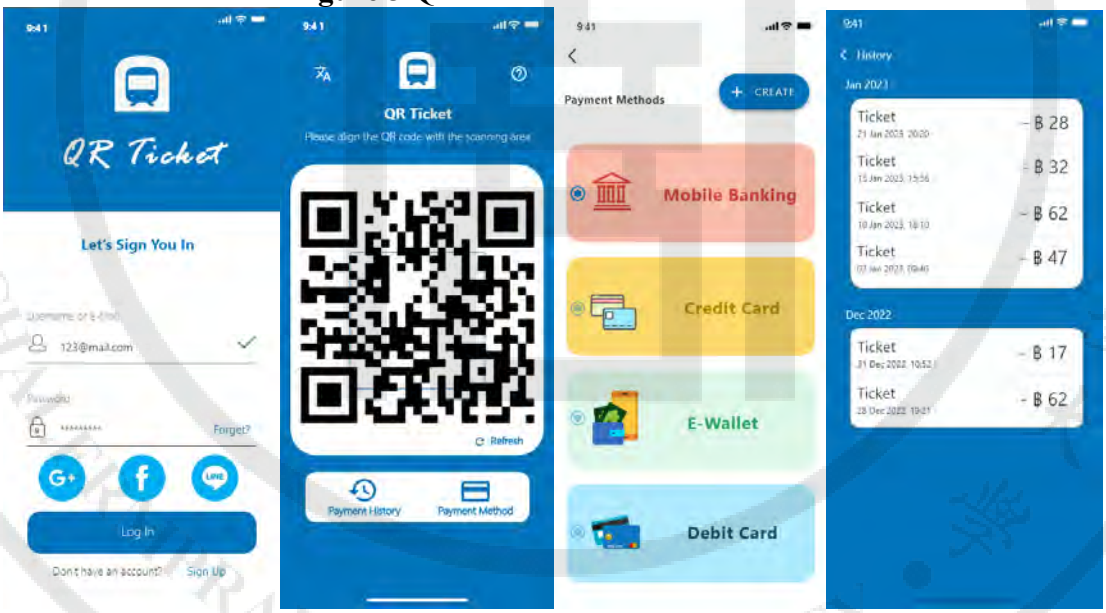

Figure 4 QR Ticket Software Prototype

Evaluation

- **Evaluation of perceived usefulness**

Data analysis shows that passengers rate the QR ticket software highly for its efficiency. The overall mean score for this scale was 4.17, so passengers rated the QR ticket software highly for saving queuing time, fast subway rides, no need to reload tickets, practicality, responsiveness and having a trusted electronic payment method, and passengers rated the perceived usefulness of the QR ticket software prototype highly (Table 8).

Table 8 Evaluation of perceived usefulness

Functions	Influence factors	Mean	Standard Deviation
Trust	QR code technology	4.15	0.916
	e-payment method	4.19	0.876
	metro company	4.11	0.931
Efficiency	save queuing time	4.53	0.787
	no need to recharge	4.31	0.843
	fast ride	4.32	0.851
Reliability	practical	4.29	0.857
	less failure	3.99	0.944
	fast response	4.21	0.930
Security	protects personal information	3.98	0.944
	protects personal property	3.92	0.962
	secure system	4.07	0.916

- **Evaluation of perceived ease of use**

Data analysis shows that passengers rate the usability of the QR ticketing software highly. The overall mean score for this scale was 4.30, so passengers rated the ease of use and the ease and speed with which QR tickets can be used highly. Passengers rated the perceived ease of use of the QR ticketing software prototype highly (Table 9).

Table 9 Evaluation of perceived ease of use

Functions	Influence factors	Mean	Standard Deviation
Usability	easy to learn	4.28	0.869
	easy to use	4.31	0.888
	convenient and fast	4.31	0.850

Intention to use QR ticket prototype

The data analysis in Table 10 shows that all items affect passengers' intention to use QR ticketing software. The overall mean score for perceived usefulness was 4.17 and the overall mean score for perceived ease of use was 4.35. Therefore, trust for perceived usefulness, efficiency and user-friendliness for perceived ease of use are important factors that affect passengers' intention to use QR ticketing software, so trust and efficiency affect perceived usefulness and user-friendliness affects usability and thus perceived ease of use.

Table 10 Intention to use

Functions	Influence factors	Mean	Standard Deviation
Perceived usefulness	trust	4.21	0.848
	efficiency	4.23	0.893
	reliability	4.11	0.841
	security	4.14	0.899
Perceived ease of use	easy to learn (usability)	4.33	0.826
	easy to use (usability)	4.33	0.948
	user-friendly (usability)	4.39	0.870

According to Table 11, it can be seen that the demographic variables of passengers have an impact on passengers' intention to use QR ticketing software. To make the results easier to analyze, the significance level for the sample of this study was chosen as 0.10. From this, it can be seen that passengers' occupation influences the perception of trust in perceived usefulness. Passengers' gender, education level, and occupation all affect the perception of efficiency in perceived usefulness. Passengers' gender affects perceived reliability in perceived usefulness. Passengers' education level and occupation affect the perception of ease of learning in perceived usefulness, representing that passengers' education level and occupation affect the perception of usability in perceived usefulness. Therefore, passengers' intention to use QR ticket software is influenced by demographic variables, and the main influencing factors are trust, efficiency, reliability, and usability.

Table 11 Demographics influence intention to use

	Gender	Education	Occupation	P
Trust	0.179	0.225	0.061	0.056
Efficiency	0.153	0.126	0.171	0.080
Reliability	0.053	0.304	0.218	0.070
Security	0.061	0.586	0.355	0.151
Easy To Learn (Usability)	0.794	0.095	0.058	0.088
Easy To Use (Usability)	0.271	0.111	0.437	0.212
User-Friendly (Usability)	0.338	0.204	0.512	0.378

7. Discussion

The most desired electronic payment by BTS Skytrain passengers is mobile banking. At this stage, passengers are more willing to use card tickets than cardless tickets, but the more educated passengers are, the more likely they are to accept cardless tickets, due to the fact that more educated passengers are better learners and more receptive to new things.

Passengers believe that QR ticketing software should use trusted ticketing technology and electronic payment providers, that the software saves passengers' time, is responsive and does not lag, that the ticketing software protects personal information and has a trusted security system and that the process is easy and fast to use.

This study designs a subway ticket that uses QR code technology. The software allows the use of electronic payment methods such as mobile banking, e-wallets, credit cards and debit cards for ticket payment, as well as features such as checking payment history, language switching and refreshing tickets. The software automatically deducts the fee, and passengers can enter and exit the station by showing the QR code. At the same time, passengers rate the QR ticket prototype highly, mainly in terms of the software's ability to save queuing time, fast subway rides, no need to top up tickets, practicality, responsiveness and a trusted electronic payment method, ease of use and quick and easy to use, so the trust, efficiency and usability of the QR ticket prototype affect passengers' intention to use the software prototype. That is, perceived usefulness and perceived ease of use affect passengers' intention to use them. Finally, demographic variables affect trust, efficiency, reliability, and usability.

8. Conclusion

The study of QR tickets was used to review existing research and issues to design a new QR ticket software for the Bangkok metro mass transit system. The researcher hopes that the designer will pay enough attention to the perceived usefulness and perceived ease of use of the QR ticket software to improve the intention of passengers to use it. It is hoped that this study will provide a theoretical basis for research related to QR ticket development.

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