เรียนรู้เพื่อรับใช้สังคม

INTENTION OF BTS SKYTRAIN PASSENGERS TO USE QR TICKET FOR METRO MASS TRANSIT SYSTEM IN BANGKOK

XIE ZEHUA

A THESIS SUBMITTED IN THE PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE MASTER OF BUSINESS ADMINISTRATION IN DIGITAL BUSINESS FACULTY OF BUSINESS ADMINISTRATION HUACHIEW CHALERMPRAKIET UNIVERSITY

YEAR 2023

INTENTION OF BTS SKYTRAIN PASSENGERS TO USE QR TICKET FOR METRO MASS TRANSIT SYSTEM IN BANGKOK

XIE ZEHUA

APPROVED THIS THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE MASTER OF BUSINESS ADMINISTRATION IN DIGITAL BUSINESS

ON DATE MAY 29, 2023

.....	.....
Dr. Kannika Daungcharone	Asst. Prof. Dr. Lanthom Jonjoubsong
Chairman of thesis committee	Thesis advisor
.....	.....
Dr. Puangchompoo Jones	Asst. Prof. Dr. Lanthom Jonjoubsong
Thesis committee	Chairman of Master of Business Administration (Digital Business)
.....	.....
Asst. Prof. Dr. Lanthom Jonjoubsong	Asst. Prof. Janya Yodnil
Thesis committee	Dean of Faculty of Business Administration

INTENTION OF BTS SKYTRAIN PASSENGERS TO USE QR TICKET FOR METRO MASS TRANSIT SYSTEM IN BANGKOK

Xie Zehua

Master of Business Administration (Digital Business)

Thesis Advisor: Asst. Prof. Dr. Lanthom Jonjoubsong

Abstract

When the metro stations are crowded, it is a hassle for passengers to buy tickets, stand in line and recharge. The purpose of this study is to provide a new QR ticket system for the Bangkok metro mass transit system and to understand the intention of passengers to use it. The study used a design science research method and a mixed research method with a quantitative questionnaire and qualitative document analysis. The questionnaire was self-selected sampling and a minimum of 168 BTS Skytrain passengers were required. Demand questionnaire received 176 and evaluation questionnaire received 175. All scales of both questionnaires were reliable and Dr. Siriwut as an expert ensures the validity of the questionnaire. The study showed that passengers' favorite electronic payment is mobile banking, and highly educated passengers are more willing to use QR ticket, and the QR ticket software meets the needs of BTS passengers by comparing the document analysis. Also, passengers have high evaluation of the QR ticket prototype designed in this study, trust, efficiency, and usability are the main needs of passengers and also the main factors that influence passengers' intention to use it. Metro should pay attention to the perceived usefulness and perceived ease of use of the software when designing QR tickets.

Keywords: E-payment, Mobile App, Metro, QR Codes ticket, Technology acceptance model

Acknowledgment

I would like to thank all the people who have helped me to complete my thesis. First of all, I would like to thank my advisor, Dr. Lanthom Jonjoubsong, for always helping and guiding me through this research, and her excellent and careful guidance has enabled me to finish my thesis on the right path. I would also like to thank my thesis committee advisor, Dr. Puangchompoo Jones, for her support and rigorous guidance to make my thesis more rigorous. I am also very grateful to Dr. Kannika Daungcharone who pointed out the problems for me during the defense so that I could revise my thesis more scientifically, critically and comprehensively. I am also grateful to Dr. Siriwut Rungruang for his repeated support in designing my questionnaire, his suggestions made it more rigorous and gave me a clearer perception of the questionnaire design.

Secondly, I would like to thank each and every BTS Skytrain passenger who participated in the data collection of this study for their support and cooperation in this study, and they're carefully filling out the questionnaire so that I could finish the study as early as possible.

Finally, I would like to thank my close friends and family for being by my side and for their endless encouragement and support throughout my study, and I express my deepest gratitude to them.

Xie Zehua

Abbreviations

AFC	Automated Fare Collection
BTS	Bangkok Mass Transit System
E-payment	Electronic Payment
MRT	Metropolitan Rapid Transit
NFC	Near Field Communication
QR	Quick Response
TAM	Technology Acceptance Model

Table of Contents

Table of Contents (Continued)

Table of Contents (Continued)

Table of Tables(Continued)

Table of Tables (Continued)

Table of Figures

Chapter1
Introduction

1.1 Introduction

During the last few years, as dominated by the ongoing development and innovation of technology, electronic payment has been fully integrated into the daily lives of human beings. According to the survey report of the World Bank (2022), electronic payment has rapidly developed due to the prevalent situation of COVID-19.As a result,76% of adults worldwide are nowusing electronic paymentmethod and this has become the most popular non-cash means of payment for business transactions.

The popularity of electronic payment likewise began to penetrate the field of public transportation, especially the metro systems. The main electronic payment methods used include Card Tickets (contactless smart card), Cardless Tickets (NFC payment, and the QR code payment).These diverse electronic payment methods provide a lot of convenience to passengers. China spearheaded the use of Cardless Tickets in public transportation, with NFC coverage of 94.1% (32), QR Code coverage of 88.2% (30) and 85.2% (29) of cities that support more than two payment methods among 34 Chinese cities for subways, according toMpaypassReport (2019). Meanwhile, Thailand has also become a major E-payment country with a large number of E-payment user groups, comprising 9.7 billion E-payment transactions in 2021 and the third highest E-payment usage rate in the world, after India and China (Leesa-Nguansuk, 2022). A large number of E-payment users in Thailand has adoptedCard Tickets in the metro system.Bangkok's Metro System consists of two major components: the BTS Skytrain (BTS) and the Metropolitan Rapid Transit (MTR).

According to the official websites of BTS (2022) and MRT (2022), the main mode of travel in the Bangkok MetroMass Transit System is still based on Card Tickets, such as the single journey tickets and the Stored Value Cards (SVC).To get on the metro, passengers are required to line uptopurchase or top-up tickets at the ticket vending machines or the ticket counters at the stations. When the stations are crowded, it is very difficult for passengers to purchase and top-up their tickets, which takes a lot of time and effort and makes them dissatisfied (Poomrittigul et al., 2019). Currently, the Bangkok Metro Mass Transit System is also starting to apply electronic payments, such as Credit Cards. Although the application of new technologies can change the way passengers purchase tickets, research conducted by Kaewratsameekul (2018) shows that passengers only use electronic payment methods that suit their specific needs.The innovation of purchasingtravel ticketsthrough the QR Codeis commonlyusedfor airport tickets, particularly on the passenger's boarding pass. From the Mpaypass Report (2019), China has applied this technology to itsMetro Mass Transit System. It is called the QR ticket and is a Cardless Ticket, itallows passengers to purchase tickets regardless of its time and location. Passengers no longer need to spend time and effort standing in line to buy or top-up their Card Tickets. By simply moving the fingers on a mobile app, the purchase of a ticket can be completed according to their travel time andcan allow entry to the station by scanning the QR code. My suggestion is that the Bangkok Metro Mass Transit System could use this Cardless Ticket to solve the above problems. Despite the convenience of this method, this type of ticket has not been used in the Thai Mass Transit System. Passengersprobably are not awareof this new payment method yet.Thai nationalsseem to maintain a wait-and-see attitude if the QR ticket system will be implemented.Given the prevailing situations,the study of the preferences of passengers to use the QR tickets in the Metro Mass Transit System in Bangkok is implicitly valuable.On the other hand, because BTS Skytrain has pioneered the use of QR code payments on

ticket machines, and because BTS also has applications and a cooperative payment program that make it easier to advance the use of QR tickets, the sample group for this study will be selected as BTS Skytrain passengers.

1.2 Problem Statement

1) Passengers of the Bangkok Metro Mass Transit System can only purchase tickets in lineat the Metro Stations.
2) Passengers on the Bangkok Metro Mass Transit System are difficult to purchase or top-up their tickets in crowded times.
3) Passengers of the Bangkok Metro Mass Transit System are hesitant to use the new electronic payment method.

1.3 Objectives

1) Tounderstand the needs of passengers of the Bangkok Metro Mass Transit System pertaining to ticket payment.
2) To proposea 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 BangkokMetro Mass Transit System.

1.4 Research Questions

1) What are the needs of passengers of the Bangkok Metro Mass TransitSystem in terms of payment for tickets?
2) What would be the physical appearance of a new system that allowspassengers of the Bangkok Metro Mass Transit System to use QR tickets?

3) What is the willingness of passengers to use the QR Tickets in the BangkokMetro Mass Transit System?

1.5 Definition of Term

Metro Mass Transit System	A Metro System is a heavy rail that runs at high speed on tracks and serves mainly urban areas as a reliable, comfortable and high-speed mode of mass transit (Loo and Li, 2006).
Electronic Payments	Electronic Payments are a way of transacting or paying for goods and services through electronic means without the need for checks and cash. It is also called E-payment (Ameerbakhsh et al., 2021).
QRTickets	QR Tickets are QR Codes in the form of metro cards, which are usually applied to mobile phone apps. Passengers hold the QR code close to the scanning position of the gate and enter the station after successful recognition (Wang and Zhang, 2019).
NFC	The Near Field Communication is a standard wireless connectivity technology (Arslan et al., 2016). The card imitation mode of NFC allows smartphones to record smart card data such as Credit Cards, Debit Cards and transportation cards, thus replacing and completing cashless payments (Statler, 2016).
Smart Cards	Smart Cards are divided into contact smart cards and contactless smart cards. The difference between these two cards is on the card chip which is in direct contact with the card reader (Mezghani, 2008). Today's

	popular payment cards such as transportation cards, Credit Cards and Debit Cards are all contactless smart cards (Leng, 2009).
Mobile Banking	Mobile Banking is an important part of E-Banking and is a type of mobile application developed by banks (Shaikh and Karjaluoto, 2015). Users no longer need to visit offline banks in person but can complete a wide range of banking services simply through mobile devices such as cell phones (Tam and Oliveira, 2017).
Mobile Wallet	A Mobile Wallet is a mobile application that contains the user's bank account or Credit Card information within the mobile application (Isaac and Sherali, 2014). A Mobile Wallet has all the features of a physical wallet and is more secure, with many of the user's cards and funds consolidated in one account (Uddin and Akhi, 2014).

1.6 Expectation Outputs

1) A new system that allows passengers of the Bangkok Metro Mass Transit System to use the QR tickets.
2) To determine if Bangkok passengers are willing to use the QR tickets.

1.7 Conclusion

In the introduction, this paper presents how China and Thailand complement the use of the metro system. China'sadoption ofCardless Tickets for the metro system has become very popular. On the other hand, Thailand, known to be a major electronic payment country, has a good potential for the QR tickets in the Bangkok Metro Mass Transit System. To design the rollout of this new QR ticket system, the

Researcher does not only emphasize on the passengers' needs but likewise study the intentions of passengers in using the QR tickets. The goal is to provide a useful reference for the future rollout of the QR tickets in the Bangkok Metro Mass Transit System.

Chapter 2
Literature Review

The Literature Review of this study is divided into five main sections. Metro MassTransit System, Electronic Payment, Technology Acceptance Model, Demographic Characteristics and Theoretical Framework. This Chapter summarizes the research methods and results of other studies conductedas well as further research-related topics based on the same topic. Finally, this study establishes the corresponding theoretical framework in the context of the actual situation of the Metro Mass Transit System of Thailand which is expected to provide a basis and guidance for the Researcher's study.

2.1 Metro Mass Transit System

Topresent a better understanding of what a Metro Mass Transit System is, the Researcher expounded its definition andelaborated onits history. In this section the electronic payments in the Metro Mass Transit Systemwill also be discussed.

2.1.1 Definition of Metro Mass Transit System

Metro Mass Transit System, also known as undergroundtrain, tube, subway or metro, is a rapid transit system that serves urban areas with railroads andallows trains to run non-stop, at high-capacity underground or above-ground, as well as in tunnels or viaducts. A metro train consists of at least two carriages, and it can carry at least 100 passengers andat the same time, has a high level of automation. There are also other types of rail systems, such as light rail, maglev or monorail technology that are normally included in the statistics of metro systems. Metro systems are somewhat unique in its classification as aform of transportation system in a city. Each system is different, varying in layout, length, capacity and quality (Fraszczyket al., 2014).

In summary, the Metro Mass Transit System is a rapid transit system that provides for the uninterrupted operation of metro trains on railroads, tunnels or on viaducts. Similarly, rail systems such as light rail, maglev or monorail technology are also included in the Metro Mass Transit System.

2.1.2 History of Metro Mass Transit System

The world's earliest Metro Mass Transit System originated in the United Kingdom. In 1800, most people in London, England travelled on foot.In 1815, steamships began operating; in 1829, horse-drawn carriages regained popularity as a means of public transportation; in 1836, the railroad opened the London Bridge while the world's first metro inaugurated its operation in 1863.In 1870, trams successfully came into existence and began to operate; in 1890, the electric tube railroad was introduced to commuters; in 1899, buses began operating; and in 1901, public trams were introduced as a transportation system (Rimmer, 2013).

Public transportation in the United States was developed early. Steam ferries operated in 1812; horse-buses began operating in 1827; horse-trams opened in 1832; trams began using them in 1883; the first U.S. metro opened in Boston in 1897; buses opened in 1905; and trolleybuses entered service in 1910 (Cudahy,1990).

Japan is an early Asian country in the development of public transportation.Horse omnibus came into service in 1869; rickshaws originated in Japan in 1870; railroad opened in 1872; horse trams came into service in 1882; trams started to be used in 1895; buses appeared in 1913; the Tokyo Metro opened in 1927; and high-speed railroads were successfully opened in 1964 (Rimmer, 2013).

As a country with thousands of years' history, China's transportation system was mostly horse-drawn carriages.Sedan chairs and rickshaws were introduced in China in the late Qing Dynasty. In 1924 trams started running in Beijing; in 1935 buses were put into use; in 1956 trolleybuses were successfully developed, and finally launched its operation 1957; on July 1, 1965, the construction of the Beijing Metro started and

was opened to traffic on October 1, 1969. Beijing became the first city in China to have a metro (Liu, 2008).

Kakizaki (2014) describes in his book thatthe tram was put into service in Bangkok in 1894, while buses came into service in 1903 and dominated the mass transit system due to the tramsthat were abolished in 1968. At the same time, Thailand also had other mass transit vehicles such as motorized tricycles and minibusses (called Songthaew in Thai).Private cars during this periodbecame popular and the surge in the numberof motor vehicles led to chaotic and congested traffic in Bangkok (Rimmer, 2013). To alleviate Bangkok's traffic problem, Thailand initiated a rapid transit project in the early 1990s and completed construction in the late 1990s. Thus, Bangkok's first mass transit system, the Bangkok Mass Transit System (BTS- Skytrain)commenced, and in 2004, another mass transit system called the Mass Rapid Transit (MTR-subway) began its operations.These two mass transit systems form the Bangkok Metro Mass Transit System(AnantsuksomsriandTontisirin, 2015).

In summary, mass transit systems in all countries are evolving (see Table 2.1). The world's first metro system opened in 1863 in London, England.The first metro system in the United States was opened in Boston in 1897, while the first metro system in Japan was opened in Tokyo in 1927. China's first metro system opened in 1969 in Beijing. Thailand's first metro system, the BTS, opened in Bangkok in 1999 and the second, the MRT, opened in 2004. Both metro systems comprised the Bangkok Metro Mass Transit System.

Table 2.1 History of Mass Transit Development in Various Countries

Year	Country				
	United Kingdom	United States	Japan	China	Thailand
1812		Steamship			
1815	Steamship			Horse-drawn carriage, Sedan chairs	
1827		Horse-bus			
1829	Horse-drawn carriage				
1832		Horse-tram			
1836	Railroad				
1863	Metro				
1869			Horse-omnibus		
1870	Tram		Rickshaw		
1872			Railroad		
1873				Rickshaw	
1882			Horse-tram		
1883		Tram			
1890	Electric tube railroad				
1894					Tram
1895			Tram		
1897		Metro			
1899	Bus				
1901	Public tram				
1903					Bus
1905		Bus			
1910		Trolleybus			

Table 2.1 (Continued)

1913			Bus		
1924				Tram	
1927			Metro		

1935		Bus	
1956		Trolleybus	
1964	High-speed railroad		
1968			Motorized tricycle, Minibus
1969		Metro	
1999			Metro

2.1.3Ticket andPayment for theMetro Mass Transit System

Since the development of the rail transit, the ticketing medium for public transport has evolved from coins, tokens and paper tickets to magnetic and contactless cards as well as electronic payment methods (Bartin et al., 2018). Automated Fare CollectionSystems (AFC) are widely used in public transport systems around the world, commonly seen in the Metro Mass Transit System (Ferreira et al., 2017). In practice, the automatic ticketing system divides the station into a paying area and a non-paying area through guardrails and gates. If a passenger wants to enter the station to take the subway, he or she has to place a smart card or token on the recognition area of the Automated Fare CollectionSystem (AFC) machine and the AFC gate will automatically open after successful recognition. This willallow the passenger to enter the paying area, that is, enter the station. The traditional ticketing currently used by the Automatic Fare Collection (AFC) system are the following: 1) Smart Card: a stored value card; 2) Travel Card: allows unlimited travel for a short time; 3) One-way Ticket: a one-way travel ticket valid only on the day of purchase, with the ticket price calculated based on itspoint of origin to its point of destination (Chandra et al.,2013).

Nowadays, electronic payment methodsare becoming more and more popular in railroad institutions around the world.Such payment methods are: 1) smart card/ticket verification 2) ticket purchase using ticketing software on cell phones, with staff

visually inspecting the ticket or scanning the QR code and 3) cell phones directly simulated as contactless tickets through NFC technology (Bartin et al., 2018). And QR tickets and NFC are the classic cardless tickets.

In the UK's London Underground, passengers can use contactless cards such as Smart Cards, Credit and Debit Cards, as well as NFC payments using Mobile Wallets (Transport for London., 2022). In reference to these electronic payment methods, the Guangzhou Metro in China also usesthe QR codes and face-swipe payments, as well as the QR tickets (Mpaypass, 2022).

In Thailand, BTS (2022) uses the QR code payment, which allows passengers to scan the QR code on the screen with their Mobile Banking or Mobile Wallet to complete payment when purchasing tickets at the ticket machines. The MRT (2022), on the other hand, adopts contactless payment (EMV), which means passengers can use an eligible Credit Card directly when entering the station, or they can link it to their Mobile Wallets and use the NFC to complete their entry.

In summary, the ticketing system of today's Metro Mass Transit System is an automated ticketing system (AFC), where passengers can purchase and use card tickets such as smart cards, travel cards and one-way tickets to pass through the station’s entrance gates. At the same time,Card Tickets and Cardless Tickets are already widespread in the Metro Mass Transit System in various countries (see Table 2.2). For the Bangkok Metro Mass Transit System, passengers can use NFC as a cardless ticket

Table2.2 Tickets andE-Payments for Metro Mass Transit Systems in Various Countries

	Country	**United Kingdom**	**China**	**Thailand**
Card Tickets	Ticket Type	Contactless smart card	Contactless smart card	Contactless smart card

	Types of E-Payments	Smart cards Credit cards Debit cards	Smart cards Credit cards Mobile wallets	Smart cards Credit cards Mobile banking
	Ticket Type	NFC	NFC Face swipe QRticket	NFC
Cardless Tickets	Types of E-Payments	Mobile wallets	Smart cards Credit cards Debit cards Mobile wallets	Mobile wallets

2.2 E-Payment

To study E-Payments, this section discusses the definition of E-Payment, the importanceofE-payment, the characteristics of E-payment systems, and the types of E-Payments and E-Payment technologies.

2.2.1Definition of E-Payment

E-Payment, basically refers to electronic payment.Although the definition of electronic payment does not have a uniform concept because of different views, many agree that electronic payment is a payment method in the context of electronic commerce (Kaur and Pathak, 2015) and, it is a form of payment that does not involve any paper cash (Hascaryani,2013). Electronic payments use electronic media to make payments (Briggs and Brooks, 2011), which is a transfer of monetary claims acceptable between the payer and the recipient (Antwiet al., 2015).Furthermore, the customer does not need a face-to-face transaction and can transfer funds to others simply through an electronic network (King and King, 2004).

On the other hand, Hanzaee and Alinejad (2012) argue that E-payment is a financial transaction between a buyer and a seller through an electronic payment mechanism. Electronic payments complete the electronic transfer of value from the payer to the recipient. Through an electronic payment mechanism and electronic payment services,it usually come with a web-based user interface allowing users to

access and manage their bank accounts and transactions remotely via the Internet (Hidayanto et al., 2015).Therefore, E-Payment is an Internet online payment in the context of E-Commerce, which is a paperless payment process.

Combined with the above literature on the definition of electronic payment, it is understood that electronic payment is a kind of non-cash payment transacted through the Internet in the context of electronic commerce.

2.2.2ImportanceofE-Payment

Non-cash transactions are increasing globally and electronic payments have become a global phenomenon considered a necessity for every government, business and individual (Aldaas, 2021). Electronic payments have changed the mind-set of how consumers pay and merchants manage their businesses. Electronic payments provide consumers with secure and convenient access to their money, reducing economic friction and reducing cash and check payments that apply to merchants, as well as expanding the guaranteed payment that is customer-base (Zandi et al., 2013).

Slozko and Pelo (2014) concluded that cashless payments can accelerate economic development because the spread of electronic payments leads to increased consumption, while instantaneous transactions allow for rapid access to financial markets and increased financial activity.

The study by Zandi et al. (2013) also emphasized that electronic payments generate guaranteed payments from merchants, have higher potential tax revenues andhave greater financial inclusion. Electronic payments supplement the economy to beingmore efficient because the increased number of users reduces transaction costs and increases the efficiency of the flow of goods and services. The same concept can also reduce transaction and opportunity costs by eliminating the need to carry cash. Electronic payments generate only one-third to one-half of the social costs of paper-based cash transactions.

On the other hand, electronic payments have become effective in reducing crime rates because people carry less cash.Reducing the chance of "cash crime" and the development of technologies related to electronic payments is said to unlock significant commercial and industrial opportunities, thereby improving people's standard of living (Armey et al., 2014). The development of technologies related to electronic payments claims to have unlock a large number of commercial and industrial opportunities, resulting to the improvement of people's standard of living (Armey et al. 2014).

More importantly, AlRefai et al. (2021) showed that electronic payments have minimized the spread of COVID-19 within communities. This justifies that electronic payment is important.

As a conclusive hypothesis, electronic payments are very important to modern people because its convenience and its security have become a necessity in people's lives. Similarly, electronic payments are said to have improved economic efficiency, stimulate economic development and increase tax revenue. Electronic paymentslikewise can reduce costs, lower crime rates and limit the spread of COVID-19. Thisvaluable innovation of electronic payments replacing cash payments has become the new mainstream payment method adopted by merchants, businesses and individual consumers.

2.2.3 Characteristics of E-Payment Systems

In this section, the characteristics of electronic payments are presented. According to Abrazhevich (2004), the characteristics of electronic payments include suitability, ease of use, security, reliability, trust, scalability, convertibility, multi-currency, interoperability, efficiency, anonymity, traceability and as a type of authorization. It had been shown (Fonchamnyo, 2013; Sciarelli et al., 2021) that trust, efficiency, reliability, security and usability (Ease of Use) somehow can influence the Technology Acceptance Model (TAM).

1)Trust

Trust is one of the most important issues in electronic payment research and one that is often brought up for discussion (Hidayanto, 2015). Other than its importance, trustislikewise an indispensable attribute in electronic payments.It guarantees the sharing of personal information, the safety of funds andthat which will involve parties not to act against the user. Trust represents users' level of acceptance in regard to the electronic payment system. Trust, on the part of users of electronic payments is valuable because they believe that their money will not be stolen or misused. Even if a particular electronic payment system is not perfect, users believe that vendors, banks andCredit Card Companies will not act against them because of the trust existing between themselves. On the other hand, trust does not only refer to the user, but likewise refer to other parties who should also trust the electronic payment system that the user utilizes as a basis for the trusted user to be willing to enter into atransaction (Kumar, 2019).

2) Efficiency

Lai and Lim (2019) stated that users' expectations of electronic payment efficiency are fast, reliable and can save time and costs. Especially for micropayment systems, speed and efficiency are of utmost importance (Kim et al., 2010). The transaction cost of electronic payment systems in processing small payments must be reasonable and must not compromise its performance without imposing high costs. Therefore, compared to Credit and Debit cards, E-Wallet software particularly PayPal can reflect this feature when paying small amounts of money online (Hidayanto et al., 2015).

3) Reliability

Reliability is important and users need a dependable electronic payment system. The successful operation of electronic payment services depends on the availability of the infrastructure, e.g., the payment system should not be poorly designed andshould

be resistant to hackers' attacks. Interruptions in payment system services are catastrophic (Hidayanto et al, 2015). Asokanet al. (2000) argue that electronic payments have only two states: occurrence and non-occurrence.It will not be in an unknown or unstable state and users cannot accept any monetary loss due to unreliable service. Therefore, electronic payment must be stable and reliable and the service can be restored in time despite the occurrence of a failure.

4) Security

Security is one of the most researched issues for electronic payments as well and also the most important.It is a decisive factor for both users of electronic payments or non-users (Naeem et al., 2020). Hidayanto et al. (2015) argue that the Internet is open and lacksa centralized management control network. Since electronic payments involve currency, payment systems are often the target of criminals.Justifiably, the infrastructure supporting E-Commerce and payment systems must be resistant to Internet attacks.

Security, notably is reflected in the ability of the payment system to guarantee the integrity and privacy of information (Tsiakis and Sthephanides, 2005). While users trust the bank of their choice, their confidence in electronic payment technology is unstable. Users are less interested in having their data excessively collected and processed for analysis (Kobsa, 2001; Kobsa, 2002). Users want to be secured when making electronic payments, while banks and payment institutions want personal or financial information and money not to be misused and stolen (Abrazhevich, 2004). When all stages of the payment process meet the user's needs and security needs, then electronic payments have reliability (Baddeley, 2004). Among others, Asokan et al. (2000) equated security with anonymity and unforgeability, so that others will not be able to forge "counterfeit" money or create their electronic tokens (Kumar, 2019). Another perspective of electronic payment security is the concept of double-spending,

where the system design of electronic payments ensures that the currency is not reused twice (Abrazhevich, 2001).

5)Usability(Ease of Use)

Usability, also known as Ease of Use, is a very important characteristic that represents the uncomplicated nature of electronic payment systems and is defined by Hidayanto et al. (2015) as "the ease with which users perceive themselves to be able to use a particular system". According to the ISO9241-11 framework, usability is "the degree to which a system, product or service can be used effectively, efficiently and satisfactorily by a particular user in a particular usage environment to achieve a particular goal" (International Organization for Standardization,2018). Similarly, many studies have shown that the easier it is to use a technology, the more useful it is (Shao et al., 2019). Therefore, electronic payments should not be complicated and the payment process should be simple and user-friendly (Guttmann, 2002). Electronic payments should be automated and completed simply and seamlessly so that users are not inconvenienced or do not encounter difficulty in paying (Abrazhevich,2004). Ching and Hayashi (2010) conclude that the success of a user-centered electronic payment system design is important in gaining user acceptance.

In summary, the E-Payment characteristics that influence the Technology Acceptance Model (TAM) are trust, efficiency, reliability, security and usability. Trust refers to the user's trust in the E-Payment system; efficiency refers to the time and cost savings for the user; reliability refers to the stability and reliability of the system; security refers to the system's ability to defend against Internet attacks and protect the user's information and privacy without losing their money; and usability (ease of use) refers to the ease with which the user can use E-Payments.

2.2.4 E-Payment Technologies

This section describes the types of technologies used for E-Payments, including Smart Cards, Near-Field Communication (NFC) and Quick Response codes (QR

codes). The literature in the following section provides detailed definitions and usage scenarios for each technology.

1) Smart Cards

The termsSmart Card, Chip Card andIntegrated Circuit Card are often used interchangeably.Today there are two main classifications of Smart Cards - Contact Smart Cards and Contactless Smart Cards.ContactSmart Cards require direct contact with the chip on the card surface when inserted into the reader, while Contactless Smart Cards only require proximity to the reader (Mezghani, 2008). Contactless Smart Cards are mainly used for transportation fare payment cards or financial payment cards and consist of an embedded secure microcontroller, internal memory and a small antenna. Since all devices use radio technology, when the Smart Card is in contact with the electromagnetic field of the reader, the antenna receives the power from the electromagnetic field and then switches on the chip in the card to turn on the wireless communication protocol.Once the protocol is successfully authenticated, a data transmission channel is established between the card and the reader. At the same time, Contactless Smart Cards can charge the card through the magnetic or electromagnetic field generated by the card reader without any contactin this case (Leng, 2009). Although Contactless Smart Cards are similar to Radio-Frequency Identification (RFID), there is still a difference because Contactless Smart Cards operate over shorter distances and have fewer frequencies available. Contactless Smart Cards use the ISO 14443 standard, which defines the transmission protocol and communication standards between the card and the reader. The Smart Card will communicate with the reader at a frequency of 13.56 MHz and its device has a limited operating distance of only 10 cm. Currently, ISO 14443A is the most widely used Contactless Smart Card standard in the world and is used primarily in transportation payments and bank payments because of its security and multi-application nature. The most typical example is Europay, Mastercard and Visa (EMV), which is a payment

method based on the Smart Payment Card technology standard, formed by the three major global payment system cards American Express (ExpressPay), MasterCard (MasterCard PayPass) and Visa (Visa Contactless) (Lacmanović et al. 2010).

2)Near Field Communication (NFC)

Arslan et al. (2016)indicate that Near Field Communication, also known as NFC, is a standard wireless connectivity technology based on RFID technology that enables proximity communication between mobile devices, personal computers and smart objects through magnetic field sensing. NFC tags consist of a chip and an antenna that can be read and written by a reader. Since NFC likewise adopts the ISO/IEC 14443 standard used for RFID technology, NFC also operates usinga frequency range of 13.56 MHz, with a maximum transmission bit rate of 424 kbit/s and a maximum operating distance of 10 cm. In most cases, NFC usually operates at a distance of 4 cm. In addition to the ISO/IEC 14443 standard, there are other specialized standards for NFC, such as Near Field Communication Interface and Protocol-1 (NFCIP-1); Near Field Communication Interface and Protocol-2 (NFCIP-2); and Near Field Communication Wired Interface (NFC-WI). The standards for testing NFCIP-1 are: ECMA-356 and ISO/IEC 22536 as well as ECMA-362 and ISO/IEC 23917 (Basili et al., 2014). According to Burkard (2012), the greatest advantage of NFC as a subset of RFID technology is its ability to be used concurrently with existing RFID infrastructure, RFID tags, or Contactless Smart Cards developed from RFID technology. NFC addresses the RFID technology's hard distinction between active and passive devices or readers and transponders.As NFC-enabled devices contain both a passive transponder and an active reader, it allows the device to read and write data and also to receive and transmit data directly. Statler (2016) shows in his book that NFC has three operation modes: discovery (read-write), peer-to-peer and card simulation. In electronic payments, the card emulation mode of NFC is typically used in payment, access and ticketing systems where the consumer's smartphone can

replace credit, debit, transit and access cards. In this case, the NFC device is like a Smart Card or Credit Card. The NFC reader creates an active RFID field and reads the card information on the phone in a contactless way to do the corresponding work. In transportation applications, NFC offers consumers a more efficient mobile or smart card spending experience, i.e., cashless payments and cashless ticketing. The most famous examples of NFC applications are Apple Pay and Samsung Pay respectively, as these are the top streams for cell phones (IOS and Android) (Pal et al., 2015).

3)Quick Response Codes (QR Codes)

Quick Response Codes, also known as QR Codes (Statler, 2016), are special two-dimensional barcodes that allow storing information in both vertical and horizontal directions, and storing more than a hundred times of data than ordinary barcodes.QR codes are composed of black modules arranged in a square pattern with a white background to encodetext, URLs (Uniform Resource Locators)for accessing stored data, web addresses (pages, locations, links, etc.), basic texts (SMS, emails, messages, alerts, etc.) or digital signals (phone numbers, coordinates, etc.).This technology is now widely used in electronic payments or advertising (Liébana-Cabanillas et al., 2015).Specialized readers can use the QR codes with auto-zooming,or readers on cameras, smartphones or such other apps. QR codes are supported by most smartphones, thus making it more accessible to the general public. (Couto et al., 2015). QR codes use many ISO standards, such as ISO/IEC 18004, ISO 22742, ISO 21849 and ISO 15394. QR codes in itself, have quality features such as omnidirectional (360°) high-speed reading, anti-distortion symbols, data recovery function, linking function, masking function, direct marking and confidentiality (Soon, 2008). Relatively, there are two types of the QR codes: Dynamic Codes and Static Codes, respectively. Dynamic Codes are specific to each transaction and the code is different for each transaction. On the other hand, a Static Code does not change; it is unique to both the merchant and the consumer. QR codes, have two payment methods:

the merchant presents the QR code and the consumer presents the QR code. When the merchant presents the QR code, the consumer opens his or her cell phone's payment software and scans the QR code presented by the merchant, confirms the amount in the program and confirms the transaction to complete the payment. When the consumer presents the QR code, the QR code associated with the payment software that the consumer presents, is scanned by the merchant to complete the transaction. Today, the QR codes are used even in transportation payments (Bradford et al., 2019).Meanwhile, Bartin et al. (2018) argue that the QR codes can be applied to tickets for ticket verification by visual or machine scanning.

In summary, there are three common technologies for electronic payments. 1) Contactless Smart Card Technology, usually used on bank cards and transportation payment cards; 2) Near Field Communication (NFC), a standard wireless connection technology, usually used on mobile payments or e-wallets; 3) Quick Response Code (QR Code), a special two-dimensional barcode technology that can be used on mobile payments and e-wallets, with merchants presenting the QR codes and consumers presenting the QR codes as two payment methods. The technology is also used in the QR tickets, where passengers need to present the QR codes for merchants to scan and verify and is a dynamic code.

2.2.5Types of E-Payments

This section describes the types of electronic payments, and the current classification of electronic payment types that varies. Khan et al. (2017) consider the types of electronic payments as Credit Cards, Debit Cards, Mobile Payments andMobile Wallets. According to the study ofSumanjeet and Roy (2017), E-Payment types include Credit Cards, Debit/ATM Cards, Smart Cards, internet banking, Paypal, Mobile Wallet or E-Wallet, E-Check and Google Wallet. Thangamuthu (2020) emphasizes that E-Payment types are Credit Cards, Debit Cards, Smart Cards, E-Wallets, Internet Banking, Mobile Payment and Amazon Payment. Mumtaza et al.

(2020) declare that the common electronic payments are Credit Cards, Mobile Banking and Mobile Wallet. Therefore, this Researcher arrives at a conclusive statement that the types of electronic payments include Credit Cards, Debit Cards,SmartCards,Mobile Banking and Mobile Wallets based on the actual situation in Bangkok, Thailand. For a more detailed description, reference ispresented on the literature summarized in the following section.

1)Credit Cards

A Credit Card is referred to as a plastic card with a unique digital account and an embedded magnetic piece that can be read by a Credit Card reader (Chen et al., 2019).Naeemet al. (2020) refer to a Credit Card as an electronic payment system issued by a financial institution to a customer and is commonly used as an online payment method. Harris et al. (2011) add further that financial institution grants a credit limit to the cardholder, who is required to pay a minimum monthly spending amount. Meanwhile, Bezovski's study (2016) states the following arguments: that the security of Credit Cards has gained the trust of users, the suitability of Credit Cards is an important factor that has contributed to its widespread use worldwide andCredit Card Companies have built a large network covering different transactions for consumers, and ensuring a huge user base. The main advantage of Credit Cards is their ease of use, as users can complete online transactions anywhere in a short period andbecause this easy-to-use plastic card eliminates the need for users to purchase any additional software or hardware. Although the high fees of Credit Cards are not suitable for small payments, aggregated or cumulative payment schemes are a payment method that can be applied to Credit Card systems and can be used for small payments.

2)Debit Cards

Debit Cards are similar to Credit Cards in that users are required to have a bank account for transactions and the amount is automatically deducted from the card's bank account (Chen et al., 2019).This method providesusers the convenience of no longer carrying cash or checks in their possession (Thangamuthu, 2020).Rather, payments made by Debit Cards are taken directly from the user's bank account without the need of any intermediary account payment. Compared to Credit Cards, Debit Cards are cheaper to use and its usage is more suitable for small payments.However, the overall security of Debit Card payments is considered to be higher in degree than Credit Card payments because banks require various forms of identification. On the other hand, although Debit Cards have a high usage rate in most countries, its special issuance conditions and regulations result to the inability to meet the payment needs of international customers (Khan et al., 2017).

3) Smart Cards

In appearance, a Smart Card is similar to a Credit or Debit Card because it is also a card made of plastic and embedded with a microchip that stores funds, personal information and work information and the balance is deducted after each payment (Thangamuthu, 2020).SinceSmart Cards can be pre-loaded, it can perform prompt payments and protect the data within the Smart Card. The encoded information is stored in the card and has a powerful processing speed (Naeem, 2020). Since 1990, Contactless Smart Cards have been used by transport agencies around the world to collect transport fares. As a payment system common to public transport systems worldwide, many Asian countries have adopted Smart Cards for public transport, such as EZ-Link in Singapore, Octopus in China and Touch’n Go in Malaysia. Meanwhile, Thailand's first integrated Smart Card ticketing that can be used for multiple modes of transport - the Spider Card or the Rabbit Card used by BTS- Skytrain, are both Smart Cards (Prayoonphan and Xu, 2019).

4)Mobile Banking

According to Shaikh and Karjaluoto (2015), Mobile Banking is usually a mobile application that is an important part of electronic banking and constitutes a variety of financial and non-financial alternative transaction channels. Mobile Banking as an electronic payment method,allows users to make financial transactions anywhere there is an internet connection through mobile devices such as cell phones, computers, tablets or smart watches (Yakean, 2020). With the improvement of mobile technology and devices, Mobile Banking has turned into a system with features such as universality, convenience and interactivity. It is immediately available and interactive banking services allow users to access accounts through mobile devices rather than physically going to the banks or assessing computer-based online banking (Gu et al., 2009). Mobile Banking is a portable service or product that includes financial services such as simple balance inquiries, review transactions, payment services, fund transfers and more complex stock transactions. It allows users to significantly reduce their time and expenses by eliminating the need to spend relatively expensive phone bills to contact the bank's Customer Call Center or spend time visiting branches (Tam and Oliveira, 2017).

5)Mobile Wallets

According to Mahapatra and Patra, (2016) aMobile Wallet is a digital account.From another source, Doan (2014) shows that a Mobile Wallet is created when your smartphone functions as a wallet: it contains digital coupons, digital currency (transactions), digital cards and digital receipts. A Mobile Wallet is usually an application that requires users to download and install it into their smartphone from an online store and users can use the Mobile Wallet to complete payments for purchases made online or offline. The software used on phones contains the user's bank account information and/or Credit Card information so the user can conveniently make payments (Isaac and Sherali, 2014). Uddin and Akhi (2014) explain that Mobile Walletsoffer all the features of today's wallets, bringing many cards

together.Similarly,Mobile Wallets also provide security features that are not available in regular wallets.Leong et al. (2020) states that the technologies made by Mobile Wallets are direct carrier billing(buyer purchases and the amount is deducted directly from the account), the QR codes and barcodes, NFC and cloud-based solutions, respectively. Take note that the QR codes and barcodes are the most popular technologies for theMobile Wallets. China is one of the major countries using Mobile Wallet. Alipay and WeChat Pay both transact payments by using the QR codes, while PromptPay in Thailand, also transacts payments by using the QR codes (Intarot and Beokhaimook, 2018).

In summary, there are five common types of electronic payments: 1) Credit Cards are plastic cards with a unique digital account and an embedded magnetic disk that allows prepayment; 2) Debit Cards, similar to Credit Cards, allows usersto make transactions through a bank account and the amount is automatically deducted from the card's bank account; 3) Smart Cards, are commonly used in transportation payments, where funds can be stored and deductions are made after payment; 4) Mobile Banking, is an application provided by banks wherein users can access the corresponding financial services, and 5) Mobile Wallet, a digital account that integrates both the user's funds and the card into the cell phone software so that the phone can be used as a wallet.

2.3 Technology Acceptance Model (TAM)

Technology Acceptance Models, also known as TAM are often used by digital product-related studies to check user acceptance (Fonchamny, 2013; Di Pietro et al. 2015; Prayoonphan and Xu, 2019; To and Trinh, 2021; Liu et al. 2022). The theoretical framework of this paper uses the Technology Acceptance Model, the definition of the Technology Acceptance Model and the factors influencing the Technology Acceptance Model that are presented separately.

2.3.1 Definition of Technology Acceptance Model

The Technology Acceptance Model, is based on the theory of rational behavior as proposed by Fishbein et al. (1975).It is considered as the most influential research model for studying the determinants of information system and information technology acceptance, mainly for predicting individuals' intention to use and accept information systems and information technology (Chen et al., 2011). Davis (1989) proposes that there are two determinants in TAM, namely Perceived Ease of Use and Perceived Usefulness. Perceived Ease of Use is defined as the extent to which a person believes that using a particular information system or information technology is not mentally or physically demanding; Perceived Usefulness is defined as the extent to which a person believes that using a particular information system or information technology will help one improve performance. Both, thePerceived Ease of Use and the Perceived Usefulness have a direct impact on the actual use of the system (Davis, 1993). Davis defineshis TAM model in 1993 (see Figure 2.1). Through statistical analysis of the TAM-related studies (Ma and Liu, 2004; King and He, 2006; Yousafzai et al., 2007), many researchers have demonstrated that TAM can serve as a model for predicting information systems or information technology usage behavior. In addition, Venkatesh and Davis (2000) suggests that TAM can be supplemented and refined by adding additional variables in practical studies. For example, Di Pietro et al. (2015) added mobile payment-related factors such as security, compatibility and attitudes toward mobile cloud services in their mobile ticketing system study.

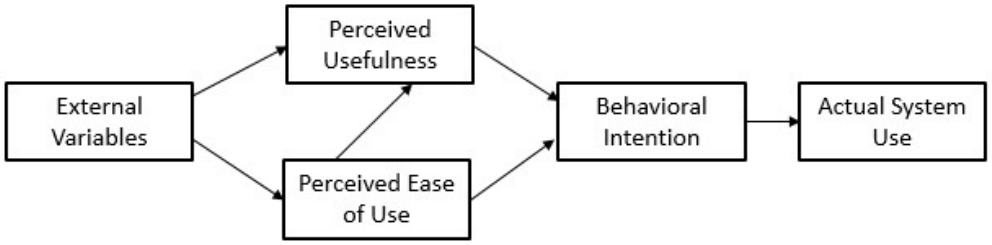


Figure 2.1 Technology Acceptance Model Framework (Davis, 1993)

2.3.2 Factors Influencing the Technology Acceptance Model

Davis (1993) states that two major determinants can directly affect the Technology Acceptance Model, namelyPerceived Usefulness and Perceived Ease of Use.

1) Perceived Usefulness

Perceived Usefulness is one of the determinants of the Technology Acceptance Model (Davis, 1989)where users feel that availing such system or technology will help them to improve their performance. With the development of TAM, more and more variables have been identified as influencing factors of Perceived Usefulness. A study by Fonchamnyo (2013) proves that trust will significantly affect users' Perceived Usefulness of E-Banking services. Through Perceived Usefulness, credit can indirectly influence the intention to use Mobile Wallets (To and Trinh, 2021). Strong evidence suggests that trust can shape customers' Perceived Usefulness of mobile internet (Alalwan et al., 2018).For example, consumers will not use mobile payments if they feel that the provider of mobile payments is lacking trust (Kaewratsameekul, 2018). Many studies have verified and confirmed the role of trust, so trust is an influential factor in Perceived Usefulness.

Chawla and Joshi (2017) elaborates in their study,the exploring factors influencing blockchain adoption that Perceived Usefulness incorporates efficiency.

Sciarelli et al. (2021) discovers that efficiency has a statistically significant effect on Perceived Usefulness. Efficiency has both a positive relationship and a positive direct relationship with Perceived Usefulness. For example, consumers believe that the efficiency of electronic payment products includes being fast, reliable and able to save time and price (Lai and Lim, 2019). Therefore, efficiency is a factor that affects Perceived Usefulness.

On the other hand, reliability also affects Perceived Usefulness. The Fonchamny (2013) results prove that reliability significantly affects customers' Perceived Usefulness of E-Banking services. Reliability significantly affects consumers' Perceived Usefulness of apparel Mobile Commerce (M-Commerce), For example, reliability is shown in the quality of the system. A practical, stable system with a fast response time can make users feel useful (Chi, 2018). Thus, reliability is a factor that affects Perceived Usefulness.

Finally, Li et al. (2017) emphasizes that security affects Perceived Usefulness indirectly, and trust plays a mediating role. Furthermore, Fonchamnyo's (2013) study proves that security trust will significantly affect users' Perceived Usefulness of E-Banking services. Security has a statistically significant effect on Perceived Usefulness (Sciarelli et al., 2021). While for Liu et al. (2022) they claim that security has a significant positive effect on consumers' Perceived Usefulness. For example, security is reflected in the degree of protection against the risk of information loss and financial loss (Kaewratsameekul, 2018). Therefore, security is a factor that affects Perceived Usefulness.

2)Perceived Ease of Use

Perceived Ease of Use, refers to the concept where users feel that using a system or technology is not mentally or physically taxing, and it is one of the determining factors of the Technology Acceptance Model. Usability, also called Ease of Use, refers to the lack of complexity of an electronic payment system. ISO 9241-11 defines

usability as, "the degree to which a system, product, or service can be used effectively, efficiently and satisfactorily to achieve a specific goal by a specific user in a specific usage environment" (International Organization for Standardization, 2018). In the same manner, Pei et al. (2015) shows that usability means users can learn and use more easily, a system, product, or service, which influencesits acceptance and use. Meanwhile, Nourallah (2020) demonstrates that the perception of usability is mainly reflected in the Ease of Use. For example, mobile payments are more likely to be accepted when consumers find them easier to use than another (Kaewratsameekul, 2018). On the other hand, content, design, image, and speed all affect users' perceptions of ease of use (Teoh et al., 2013). This shows that usability is equivalent to,and is an influencing factor of Perceived Ease of Use.

In summary, the Technology Acceptance Model is a model usedto infer people's intention to accept and use information technology or systems. The two major determinants of this model arePerceivedUsefulness and Perceived Ease of Use, respectively. Among them, trust, efficiency, reliability and security are the influencing factors of Perceived Usefulness. Usability (Ease of Use) is the influencing factor of Perceived Ease of Use.

2.4Demographic Characteristics

Many studies have demonstrated that Demographic Characteristics relative to gender, education level and occupation, affect technology acceptance (Lwoga and Lwoga, 2017; Fontes et al., 2017; Vinitha et al., 2017). In this section, three characteristics of passengers are considered i.e., gender, education and occupation, in as much as they may influence the intention to use the QR tickets.

1) Gender

Gender is a common feature in demographic profiling. Gender characteristics have been used in papers related to the use of electronic payments in public

transportation (Prayoonphan et al., 2019). Meanwhile, research by Lwoga and Lwoga (2017) state that gender differences have a significant impact on the intentionto use mobile payments. For example, the mobility and reputation of mobile payment platforms affect men's intention to use them, while customization and security affect women's intention to use them (Shao et al., 2019). Therefore, in this study, since gender can likely affect passengers' intention to use the QR tickets, it is necessary to consider gender as a factor influencing passengers' use of the QR tickets.

2) Education

E-Payment, as an evolving and emerging technology, requires users to learn its operation and usage before availing it.For users with higher levels of education, there are more opportunities to learn and access new electronic payments (Kaewratsameekul, 2018). Some studies have shown that people with higher education levels are more likely to accept the use of electronic payments in public transportation (Fontes et al., 2017). Since the assumption is that education can likely influence passengers' intention to use the QR tickets, therefore,this study must consider education as a factor influencing passengers' use of the QR tickets.

3) Occupation

Occupation, as a major demographic characteristic, has been shown to have a significant effect on the intentionto use E-Payment (Vinitha et al., 2017). A study shows that students are more likely to use electronic payments in public transportation in Beijing, China (Fontes et al., 2017). Also, Tarigan et al. (2022) show that students are the largest mobile payment user group, followed by employees.For this reason, since there is a probability that occupation also affects passengers' intentionto use the QR tickets, this study considers occupation as a factor that affects passengers' use of the QR tickets.

In summary, many studies have shown that the three main characteristics, gender, education and occupation, may all be influential factors in the Technology Acceptance Model.

2.5Theoreticalframework

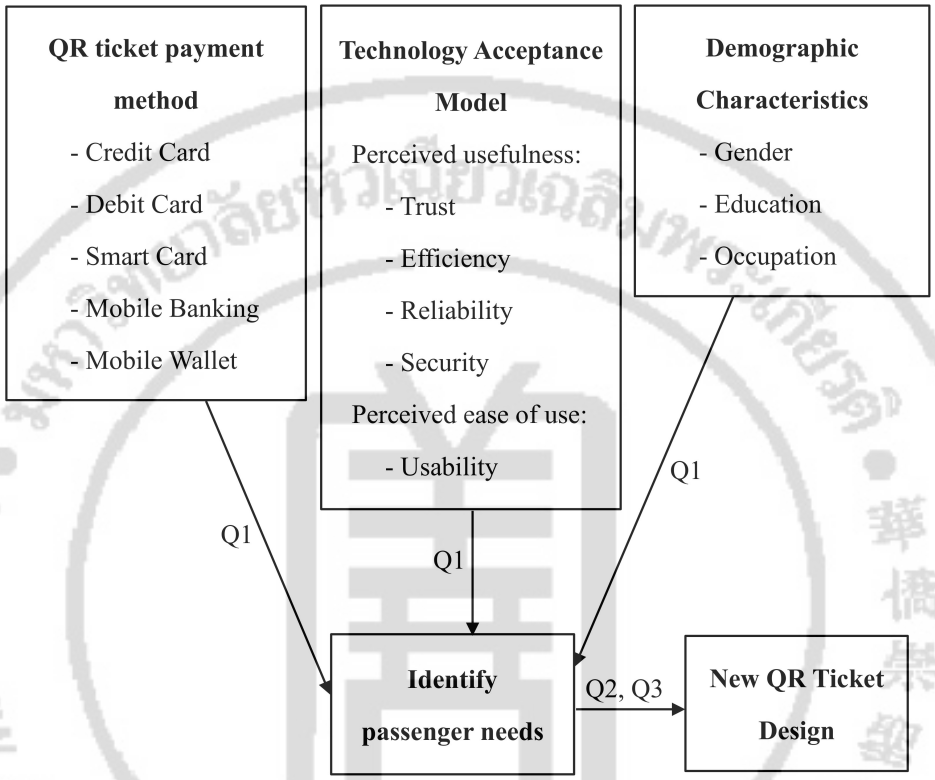


Figure 2.2Theoretical Framework

Research Questions

1) What are the needs of passengers of the Bangkok Metro Mass TransitSystem in terms of payment for tickets?
2) What would be the physical appearance of a new system that allowspassengers of the Bangkok Metro Mass Transit System to use QR tickets?

3) What is the willingness of passengers to use the QR Tickets in the BangkokMetro Mass Transit System?

2.6 Conclusion

The Metro Mass Transit System is a kind of rapid transit system serving the city. The first metro in Bangkok, Thailand known as BTS SkyTrain was opened in 1999.Presently, the automatic ticketing system (AFC) of the Bangkok Metro Mass Transit System uses not only card tickets such as smart cards, single journey tickets and credit cards but also cardless tickets such as NFC. Electronic payment is a non-cash payment using the Internet, which is important for economic development, social security and public health. Electronic payment has various characteristics such as package trust, efficiency, reliability, security and usability (Ease of Use).These characteristics also affect the acceptance of electronic payment by users. The mainstream technologies used for electronic payments are divided into Contactless Smart Card technology, Near-Field Communication (NFC) technology andthe Quick Response Code (QR Code) technology. The mainstream electronic payment methods based on these three technologies today are Credit Cards, Debit Cards, Smart Cards, Mobile Banking andMobile Wallets. According to the literature related to Technology Acceptance Model, Perceived Ease of Use and Perceived Usefulness will determine people's intention to use the method as mentioned. Among these, trust, efficiency, reliability and security are the influencing factors of Perceived Usefulness. Usability (Ease of Use) is an influencing factor of Perceived Ease of Use. Meanwhile, demographic characteristics such as gender, education and occupation affect the Technology Acceptance Model.Finally, all of the aforementioned literature forms the research framework of this study.

Chapter 3
Research Methodology

This Chapter describes the research methodology used in this study, which is divided into five main sections: Research Methodology and Type, Population and Sample, Data Gathering and Research Tool Development, and Data Analysis and Research Quality.

3.1 Research Methodology and Type

Design Science Research Methodology as well as the Mixed Research Method combining qualitative and quantitative approaches are methods used in this study. The Design Science Research Methodology is an approach widely used in the field of information systems and is likewise applied to research projects in technology and information systems and systems frameworks (Lopes and Reis, 2022). Essentially Design Science Research is a problem-solving process used by creating an IT product designed to solve an organizational problem and evaluating it using quantitative or qualitative methods so that one can understand the problem that the product solves and the feasibility of the method to solve that problem (Hevner et al., 2004). In his book, Vaishnavi (2007) writes that the Design Scientific Research process is the awareness ofthe problem, suggestion, development, evaluation and conclusion respectively. Relatively, this research process will be divided into five points as follows:

1) Awareness of Problem: The aim is to identify the needs of passengers, first by using a questionnaire to analyze the needs of passengers in Bangkok, and by using the document analysis through the Qualitative Research Method (Bowen, 2009), to understand the QR tickets used in the Guangzhou Metro. Secondly, by combining the

data from the questionnaire and the document analysis and summary to determine whether the QR tickets meet the needs of Bangkok passengers.

2) Suggestion: Formulating a conceptual design of the QR ticketing software for the Bangkok Metro Mass Transit System.

3) Prototyping:Designing the QR ticket prototype using an infographic to inform passengers about the QR tickets by introducing and demonstrating the process, functions and payment methods of the QR tickets.

4) Evaluation: The evaluation method used in this study is through Testing (Hevner et al., 2004). Passengers' perceptions of the QR tickets were collected through a questionnaire and finally analyzed to find out passengers' intention to use the QR tickets.

5) Conclusion: The final report of the study analyzes whether the QR tickets can be used in the Bangkok Metro Mass Transit System by summarizing passengers' demand and intention to use the QR tickets.

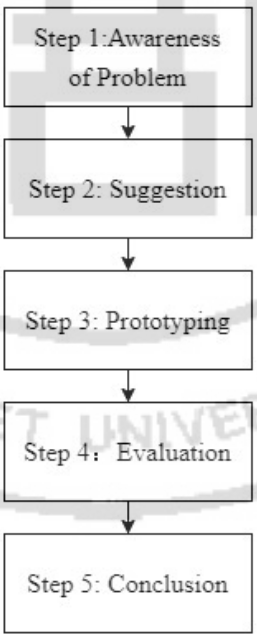


Figure 3.1Research flow

3.2 Population and Sample

3.2.1 Population

This study focuses on the intention of passengers in using the QR tickets in the Bangkok Metro Mass Transit System and quantitative studies are imperative to analyze the needs of passengers and evaluate the QR tickets. And because BTS Skytrain is the earliest metro built, it has a long history and a large number of passengers. The study population comprises the passengers who ride the BTS Skytrain in Bangkok. According to the announcement of BTSGIF (2022), the number of passengers who took the BTS Skytrain in August 2022 reached 13,800,000 people.However, because the number of BTS passengers' changes daily, this keeps the sample group in an unknown state.

3.2.2 Sample

The sample in this study is used in two steps, which are: identifying passenger needs, and evaluating artifacts. Both the identification of passenger needs and the evaluation of artifacts are quantitative studies.

1) Sampling Technique

The sampling technique used to identify passenger demand and evaluate artifacts was self-selected sampling, which is a non-probability sampling that is often used in online surveys (Bethlehem, 2015). After the researcher distributes the questionnaire, respondents can choose whether or not to participate in the survey, if they wish. The use of self-selected sampling is necessary to have all individuals or organizations in a given unit or case actively participate in the study. Although the Researcher does not have direct contact, samples that are collected can meet the required criteria in a short time (Sharma, 2017). In this study, the respondents are passengers who travel on the BTS Skytrain and the Researcher uses Google Forms to collect the sample data and distribute the questionnaire through the Online social platforms.

2) Sample Size

Chaokromthong and Sintao (2021) statesthat The Cochran Formula is used to determine the sample size when the population size is large and unknown. The formula is $n = Z^2pq/e^2$ (see Figure 3.1), where n is the sample size, Z^2 is the standard error unit confidence interval square, p is the population proportion, q is 1 - p, and e^2 is the acceptable sampling error. From the literature review, it is known that the average daily ridership on the BTS Skytrain is 12.5% of the population of Bangkok (Egis, 2022), assuming a 95% confidence level (marginal error of 0.05).The Cochran formula was used to calculate the sample size.The sample size was calculated to be about 168 people (n=0.125*(1-0.125) *(1.96) ^{2}/ (0.05) ^{2}=168).

$$n_0 = \frac{Z^2pq}{e^2}$$

Figure 3.2 Cochran Formula (Israel, 1992)

This results in a minimum sample size of 168 for both the demand questionnaire and the evaluation questionnaire. Because the number of valid samples collected by both questionnaires exceeded 168, the sample size of the questionnaires met the requirements. On the other hand, because the content and distribution time of the demand questionnaire and the evaluation questionnaire are different, and the number of distributions of both questionnaires far exceeds the required number, there will be a difference in the number of valid questionnaires returned by the two questionnaires.Also, because the sampling in this study was self-selected, the sample group was BTS passengers, and the demographic factors were divided into gender, education and occupation, the easily distinguishable factors were male, female,

student and employee. Therefore, the researcher distributed questionnaires to BTS passengers who met the demographic factors at BTS stations, universities, and relevant social networking sites.

A total of 176 samples were collected for this requirement questionnaire (Table3.1), of which 50 (28.4%) were male respondents and 126 (71.6%) were female respondents. The educational level of the respondents was divided into three stages, with 6 (3.4%) below a bachelor's degree, 111 (63.1%) bachelor's degree and 59 (33.5%) with a master's degree and above. Finally, there were 87 (49.4%) students and 89 (50.6%) employees.

Table 3.1 Demographic information of the demand questionnaire

Item		Frequency	Percentage
Gender	Male	50	28.4
	Female	126	71.6
Education level	Under Bachelor degree	6	3.4
	Bachelor degree	111	63.1
	Master’s degree or higher	59	33.5
Occupation	Student	87	49.4
	Employee	89	50.6
Total		176	100

For this evaluation questionnaire, a total of 175 demographic samples were collected (Table 3.2), including gender, education level, and occupation. Among them, there were 81 male respondents (46.3%) and 94 female respondents (53.7%). The educational level of the respondents can be divided into three parts, with 34 (19.4%) having less than a bachelor's degree, 102 (58.3%) having a bachelor's degree, and 39 (22.3%) having a master's degree or higher. Finally, according to occupation, there were 98 students (56%) and 77 employees (44%).

Table 3.2Demographic information of the evaluation questionnaire

Item		Frequency	Percentage
Gender	Male	81	46.3
	Female	94	53.7
Education level	Under Bachelor degree	34	19.4
	Bachelor degree	102	58.3
	Master's degree or higher	39	22.3
Occupation	Student	98	56
	Employee	77	44
Total		175	100

3.3 Data Gathering and Research Tool Development

3.3.1 Data Gathering

1) Quantitative

In this study, a questionnaire was used to measure passenger needs using multiple-choice questions and a five-point Likert scale.Also, Likert scales have been used to measure the evaluation of artifacts and people's intention to use them. The Likert Scale is commonly used in questionnaire summaries. It is a procedure that measures attitude scales and it consists of a series of questions and five response options: strongly agree, agree, undecided, disagree and strongly disagree. The qualitative attributes of attitudes, perceptions and opinions can be transformed quantitatively through a Likert Scale. The abstract ideas, experiences and questions are combined into some declarative items guided by the purpose of the study, thus quantifying the subjective preferences of perceptions, feelings and actions validly and reliably (Joshiet al., 2015).

2) Qualitative

Document analysis was used in this study. In chapter 5, the QR ticket software is analyzed by comparing 11 related articles from China and Thailand (Table 3.3).Combine passenger needs and analyze whether QR code ticketing software meets

Thailand's needs, and to derive the concept of QR ticket and finally design the software prototype. Document analysis, on the other hand, is a type of qualitative research that allows empirical data to be obtained in a cost-effective manner (Bowen, 2009). Documents are created by individuals or groups in a socio-historical context, usually personal letters and documents, public materials, official documents and selected electronic resources and these are a cost-effective and fruitful source of important research material (Davie and Wyatt, 2021).

Table3.3 Document List

No.	Document Title
1	Walking distance of commuters after modal shift to rail transit in Bangkok(Ratanawaraha et al., 2015)
2	Report on the intelligent travel of the Chinese people (Fitgroup, 2018)
3	The simulation of queuing model for Bangkok rapid transit train ticket system using Python.(Poomrittigul et al., 2019)
4	Research on the Convenience of Public Transport Purchase and Payment ——Taking Guang Zhou Metro for Example(Tan, 2019)
5	Application Analysis of Diversified Payment in Guangzhou Metro Ticketing System (Chen, 2019)
6	Impact of gentrification on travel behavior in transit-oriented development areas in Bangkok, Thailand(Matsuyukiet al., 2020)
7	China’s digital payments revolution. (Klein, 2020)
8	Traffic Flow of Metro Stations and Population Travel Differentiation in Guangzhou(Ye et al., 2021)
9	Ticketing procedure(Guangzhou metro, 2021)
10	Popular Payment Methods in Thailand: What Consumers Want(2C2P, 2022)
11	BTS Skytrain - apps on Google Play (BTS,2023)

3.3.2 Research Tool Development

1) Questionnaire

The questionnaire is formulated based on the research objectives, literature review and theoretical framework. The questionnaire for this step consists of three parts. The first part is demographic, using single-choice questions to collect respondents' personal information, such as gender, education level and occupation. The second part investigates electronic payment habits through the use of multiple-choice questions to collect the payment methods or payment platforms that passengers usually use, such as Credit Cards, Debit Cards, Smart Cards, Mobile Banking and Mobile wallets. The third part collects passengers' needs and attitudes toward software features by using a five-point Likert Scale to analyze the features that the QR tickets should have. The detailed questionnaire is added to Appendix B.

2) Conceptual Design

In this step, the Researcher derived passenger needs based on the analysis in the previous step and use documentary analysis of the Guangzhou Metro, the data from both sources were combined to analyze whether the QR tickets used by the Guangzhou Metro met the needs of passengers in Bangkok, to design the concept of QR ticket usage process, functions and electronic payment methods. Because Guangzhou metro is the first metro in China and the world to use QR tickets for the entire line, it is very representative (China Guangzhou Release, 2017), so Guangzhou metro is used as the sample for document analysis.

3) Prototype Design

In this step, this study uses infographics to design and present the prototype. Infographics are a form of data visualization that can outrightly convey complex, important and real information within a limited space and art form. Infographics are popular on the Web and they can be used to make information easier for readers to read and understand through the use of sound and motion in a multimedia format such

as video or animation, enabling it to analyze or evaluate the information (Siricharoen and Siricharoen, 2015). The infographic is presented to the passengers in the form of animations so that they understand the functions, usage and electronic payment methods that the QR tickets include.

4)Testing

The test was conducted through a questionnaire that was constructed based on the study objectives, literature review, and theoretical framework. The first part was a screening question that used single-choice questions to screen out passengers who traveled on the BTS Skytrain. The second part was demographic, using single-choice questions to collect respondents' personal information, such as gender, education level, and occupation. The third part collects passengers' evaluation of the QR ticketing software prototype through a five-point Likert scale. The fourth section collected passengers' intentions to use QR Ticket through a five-point Likert scale. The detailed survey questionnaire is added to Appendix C.

3.4 Data Analysis

To analyze the quantitative data collected through the questionnaire, descriptive statistics are used in this study. Descriptive statistics measures frequencies, percentages, means, medians, variances, standard deviations and chi-square (Mishra et al., 2019). Since this study uses a five-point Likert Scale, Karaci's (2016) class score range will use to study the needs of passengers and their intention to use QR tickets.Linear regression analysis will also be used to study the usage intention of passengers.Regression analysis is a widely used statistical technique to build models based on a set of data for two or more variables, while multiple linear regression is more commonly used and is capable of analyzing multiple predictors or variables (Baždarić et al., 2021).

Table 3.4 Five-point Likert-type scale score range (Karaci, 2016)

Point value	Evaluation results
1.00 - 1.80	I definitely disagree
1.81 - 2.60	I disagree
2.61 - 3.40	I am neutral
3.41 - 4.20	I agree
4.21 - 5.00	I definitely agree

3.5 Research Quality

3.5.1 Reliability

Sürücü and MASLAKÇI (2020) shows that reliability refers to the stability and consistency of a measurement instrument over time, which means that the instrument should yield similar results when applied at different times. In quantitative studies using scales, Cronbach's Alpha Coefficient is commonly used to determine reliability based on internal consistency, which is one of the most popular and widely used methods. The formula yields values between 0 and 1, with values above 0.70 implying reliability. Since the quantitative study of this research also uses the scale, the Researcher also uses Cronbach's Alpha Coefficient to test the consistency of the data and thus verify reliability.According to Table 3.4 and Table 3.5, by testing the collected questionnaires, the reliability analysis of the questionnaires in this study showed that the Cronbach's α for perceived usability was 0.987, the Cronbach's α for perceived ease of use was 0.96. The Cronbach's α for perceived usability evaluation was 0.940, the Cronbach's α for perceived ease of use evaluation was 0.874, and the Cronbach's α for intention to use was 9.22. This shows that the reliability of most of the scales is above 0.9 and the scales have very good reliability.

Table 3.5 Demand questionnaire reliability analysis n=176

Item	Cronbach'sAlpha	Interpretationfor Reliability
Perceived usability	0.987	Excellent
Perceived ease of use	0.960	Excellent

Table 3.6 Evaluation questionnaire reliability analysis n=175

Item	Cronbach'sAlpha	Interpretationfor Reliability
Perceptual usefulness evaluation	0.940	Excellent
Perceptual ease of use evaluation	0.874	Great
Intention to use	0.922	Excellent

3.5.2 Validity

Validity is defined in quantitative research as the extent to which validity is measured accurately and content validity responds to the extent to which the study covers the target constructs and a panel of experts can assess validity (Almanasreh et al., 2019). Therefore, in this study, in order to ensure the validity of the study, an expert, Dr. Siriwut, will be invited to test the validity of the questionnaire and to modify the questionnaire according to the evaluation suggestions made by this expert. Since Dr. Siriwut is very good at quantitative questionnaires, especially the scale questions about the technology acceptance model, he will be invited to conduct the questionnaire testing in this study.

3.5.3 Ethical Issue

All data and information collected in this study will be used for this research and is strictly confidential and will not be used for any commercial activities or illegal acts. The questionnaire is intended to inform the purpose of the study and the

importance of this study and ensures that the data sources are authentic and reliable.Finally, this study was submitted to the Ethics Committee of Huachiew Chalermprakiet University for review and was approved by the committee.

3.6 Duration of Research

The study plan and dates for this study are shown in Table 3.6

Activity	2022							2023		
	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
1. Preparation / Plan										
2. Design proposals and questionnaires										
3. Collect data and analyze data										
4. Discuss research results										

Table 3.7 Duration of research

3.7 Conclusion

This study adopted a Design Science Research approach and used a Mixed Research Method combining qualitative and quantitative research. The research process was divided into five steps:1) Awareness of Problem; 2) Suggestion; 3) Prototyping; 4) Evaluation; and 5) Conclusion. The study sample was divided into two parts, the questionnaire survey was conducted for 176 passengers who rode the BTS sky train and the evaluation artifacts questionnaire survey was conducted for 175 passengers who rode the BTS sky train. This study used questionnaires to obtain data,

and the data and information collected were used only for this study and were kept strictly confidential.

Chapter 4
Requirement Analysis

This chapter introduces the passengers' needs for the new ticket system and was divided into 3 parts: Electronic payment habits, ticket types, and identification needs. Moreover, a prototype of the new ticket system will be designed based on the passengers' requirements, derived from the analysis within this section.

4.1E-payment habits

This section will be describing the information on demand for electronic payments, collected through passengers. A sample of 176 BTS Skytrain passengers was received through an online questionnaire.Followed by a descriptive analysis of the quantitative data. This section analyzes two aspects of passengers' e-payment needs:daily e-payment habits, and e-payment needs for the metro.Also,common types of electronic payments were sampled as follows: credit cards, debit cards, smart cards, mobile banking, and e-wallets.

4.1.1 Daily e-payment habits

In terms of ticket type preference, the data collected show a large number of passengers use mobile banking for their daily electronic payments, accounting for 46.4%, followed by the use of debit cards at 17.1%, e-wallets at 16%, credit cards at 15.6%, and smart cards with the least number of only 4.9%. The exact number of people with payment habits has been shown in Table 4.1 below.

Table 4.1 E-payment habits (Multiple Choice)

Item	Responses		n
	n	Percentage	
Credit Card	41	15.6	176
Debit Card	45	17.1	

Table 4.1 (Continued)

Smart Card	13	4.9
Mobile Banking	122	46.4
E-Wallet	42	16.0
Total	263	100

4.1.2 E-payment needs for the metro

Passengers have the highest demand for mobile banking as an e-payment method when using BTS Skytrain at 45.7%, followed by the demand for e-wallets at 18.1%, the demand for debit cards at 4.9%, the demand for smart card at 10.9%, and last, credit cards for 10.4%. The exact number of demands is shown in Table 4.2.

Table 4.2 E-payment needs (Multiple Choice)

Item	Responses		n
	n	Percentage	
Credit Card	23	10.4	176
Debit Card	33	14.9	
Smart Card	24	10.9	
Mobile Banking	101	45.7	
E-Wallet	40	18.1	
Total	221	100	

4. 2 Ticket Type

This section will be describing passengers' preferences and perceptions for cardless tickets. A sample of 176 BTS Skytrain passengers was received through an online survey questionnaire, followed by a descriptive analysis of the quantitative data. The collected data were then subjected to a chi-square test to analyze the influencing factors. In this section, two main aspects of ticket demand are analyzed: ticket type preference and perception of cardless tickets. Also, the perception of cardless tickets

can be divided into two points: the perceived usefulness demand and the perceived ease of demand.

4.2.1 Ticket type preference

1)Description

In terms of ticket type preference,the collected data showed that the number of passengers preferring to use card tickets over cardless tickets when riding the metro is 59.8% for card tickets and 40.2% for cardless tickets, with specific numbers shown in Table 4.3.

Table 4.3 Ticket preference (Multiple Choice)

Item	Responses		n
	n	Percentage	
Card Ticket	113	59.8	
Cardless Ticket	76	40.2	176
Total	189	100	

2) Chi-square test

Cardinality tests are conducted by statistical analysis software on the characteristics of passengers, i.e., gender, education level, and occupation, respectively, about ticket type preference. Hypotheses will be created and then tested based on the results of the chi-square test. The results of the chi-square test and hypothesis testing are shown in Table 4.4.

Table 4.4 The impact of passengers' gender, education level and occupation on the choice of ticket type.

Factor	Item	Ticket Type		Total	χ^2	*p*	HypothesisTest Results
		Card Tickets	Cardless Tickets				
Gender	Male	35	23	58	0.011	0.917	No relationship
	Female	78	53	131			
Total		113	76	189			
Education level	Under Bachelor degree	5	1	6	8.166	0.017*	Relationship
	Bachelor degree	79	41	120			
	Master's degree or higher	29	34	63			
Total		113	76	189			
Occupation	Student	59	37	96	0.226	0.634	No relationship
	Employee	54	39	93			
Total		113	76	189			

* $p<0.05$ ** $p<0.01$

Hypothesis 1 of this study hypothesizes that relationships are present between gender, education level, and occupation in demographic characteristics and passengers' preference for the type of ticket. More specifically as follow:

H1a: There is a relationship between the passenger's gender and the preferred choice of fare type.

H1b: There is a relationship between the education level of passengers and the preferred choice of ticket type.

H1c: There is a relationship between the passenger's occupation and the preferred choice of ticket type.

According to Table 4.6, (1) gender ($p=0.917, p>0.05$) did not present correlation to the preferred choice of ticket type. Therefore, hypothesis H1a was not supported. (2) Education ($p=0.017$, $p<0.05$) showed relevant correlation with the preferred choice of ticket type. Therefore, hypothesis H1b was supported. (3) No correlation was present between occupation ($p=0.634$, $p>0.05$) and preferred choice of ticket type. Therefore, hypothesis H1c was not supported.

In addition, due to significant variability in the preference choice of education and ticket type, a comparative analysis of the specific differences shows (Table 4.5) that education level of passenger correlates positively to the preference of using a cardless ticket. The higher the education level, the more they were inclined to use a cardless ticket.

4.3 Perception of QR ticket

This section describes the requirements collected for the QR ticketing software. A total sample of 176 BTS Skytrain passengers was received through an online survey questionnaire, followed by a descriptive analysis of the quantitative data. The collected data was then subjected to a chi-square test to analyze the influencing factors. In this section, two main aspects of QR ticketing software requirements were

analyzed: perceived usefulness and perceived ease of use. Since perceived usefulness and perceived ease of use affect passenger acceptance of the ticketing software, studying the factors that affect passengers' perceived usefulness and perceived ease of use can yield passenger demand for the ticketing software.

4.3.1 Perceived usefulness

1)Description

In this study, the four main factors of perceived usefulness were designed into 12 items that will be used for the questionnaire survey (Table 4.5)

Table 4.5 Describe statistical perceived usefulness (n=176)

Factor	Item	Mean	Standard Deviation	Evaluation Results
Trust	E-payment provider	3.40	1.478	Neutral
	Ticketing technology	3.44	1.449	Agree
	Metro company	3.33	1.440	Neutral
	Average of trustfactors	3.39	1.456	Neutral
Efficiency	Saves time	3.41	1.059	Agree
	Saves money	3.35	1.462	Neutral
	No lag	3.41	1.391	Agree
	Average of efficiency factors	3.39	1.304	Neutral
Reliability	Fast response time	3.41	1.459	Agree
	Practical	3.30	1.456	Neutral
	Trouble-free	3.30	1.420	Neutral
	Average of reliabilityfactors	3.34	1.445	Neutral
Security	Protects personal information	3.38	1.460	Neutral
	Protects personal property	3.33	1.440	Neutral
	Trusted security system	3.38	1.507	Neutral
	Average of securityfactors	3.36	1.469	Neutral
Average of all factors		3.37	1.456	Neutral

Given the questionnaires, analysis of data collected through the questionnaire were done, in which most appears to be neutral and does not contribute to or cause

any notable impact. Further into the analysis, the items that influenced passengers' perceived usefulness were ticket technology, timesaving, no lag, and fast response time. Out of these items, ticket technology was the most influential item. The mean value of this scale is 3.37, and more than 3.37 means that passengers agree more with the factor. At the same time, the mean standard deviation of the scale is 1.456, implying a relatively large degree of dispersion for all items, indicating that there is a large divergence in passengers' perceived usefulness of the ticketing software.Resulting in a neutral attitude toward most items. According to Table 4.2, the main factors affecting passengers' perceived usefulness are trust and efficiency. These main influencing factors are consistent with the findings of Alalwan et al. (2018); Sciarelli et al. (2021) that perceived usefulness is influenced by trust, efficiency. Moreover, the factors that most passengers agree on perceived usefulness are ticketing technology, electronic payment providers, timesaving, no lag, fast response time, protection of personal information, and a trusted security system.These specific factors are consistent with the findings of previous researchers (Kaewratsameekul, 2018; Lai and Lim, 2019; Chi, 2018)

In short, passengers want a QR ticket that uses ticketing technology from electronic payment providers that passengers trust, saves time, responsive, and keeps their personal information secured.

2) Chi-square test

A chi-square test of passenger's fare preference versus passenger's perceived availability is performed by using a statistical analysis software. Hypotheses have been created and then tested based on the results of the chi-square test. The results of the chi-square test and hypotheses testing are shown in Table 4.6.

Table 4.6 The impact of passenger's ticket preference on the choice of perceived usability.

Factor	Perceived usefulness					Total	χ^2	*p*	HypothesisTest Results
	strongly disagree	disagree	neutral	agree	strongly agree				
E-payment provider									
Card Ticket	21	14	7	31	40	113			
Cardless Ticket	12	10	11	24	19	76	5.337	0.254	No relationship
Total	33	24	18	55	59	189			
Ticketing technology									
Card Ticket	22	11	10	31	39	113			
Cardless Ticket	10	8	15	23	20	76	6.275	0.180	No relationship
Total	32	19	25	54	59	189			
Metro company									
Card Ticket	23	12	13	35	30	113			
Cardless Ticket	10	10	15	22	19	76	3.782	0.436	No relationship
Total	33	22	28	57	49	189			
Saves time									
Card Ticket	18	14	13	29	39	113			
Cardless Ticket	16	8	10	19	23	76	1.159	0.885	No relationship
Table 4.6 (Continued)									
Total	34	22	23	48	62	189			

Saves money									
Card Ticket	19		15	16	26	37	113		
Cardless Ticket	11		13	13	20	19	76	1.988	0.738	No relationship
Total	30		28	29	46	56	189		
Not lag									
Card Ticket	17		19	11	32	34	113		
Cardless Ticket	7		12	14	25	18	76	4.832	0.305	No relationship
Total	24		31	25	57	52	189		
Fast response time									
Card Ticket	19		16	10	30	38	113		
Cardless Ticket	10		11	12	24	19	76	3.803	0.433	No relationship
Total	29		27	22	54	57	189		
Practical									
Card Ticket	18		18	9	39	29	113		
Cardless Ticket	13		12	8	24	18	76	0.597	0.963	No relationship
Total	31		31	17	63	47	189		
Trouble-free									

Table 4.6 (Continued)

Card Ticket	19	16	16	30	32	113		
Cardless Ticket	10	15	13	22	16	76	2.554	0.635	No relationship
Total	29	31	29	52	48	189		
Protects personal information								

Card Ticket	21	13	16	27	36	113			
Cardless Ticket	10	12	12	22	20	76	2.447	0.654	No relationship
Total	31	25	28	49	56	189			
Protects personal property									
Card Ticket	20	16	16	28	33	113			
Cardless Ticket	10	13	11	24	18	76	2.127	0.712	No relationship
Total	30	29	27	52	51	189			
Trusted security system									
Card Ticket	21	14	14	27	37	113			
Cardless Ticket	13	11	9	18	25	76	0.217	0.995	No relationship
Total	34	25	23	45	62	189			

* $p<0.05$ ** $p<0.01$

Hypothesis 2 of this study hypothesizes that relationships are present between genders in demographic characteristics and the perceived usefulness of passengers. More specifically as follow:

H2a: There is a relationship between passengers' ticket preferences and the need for a trusted e-payment provider.

H2b: Passengers' ticket preferences are related to the demand for trusted ticketing technology.

H2c: There is a relationship between passengers' ticket preferences and the demand for trusted metro companies.

H2d: Passengers' ticket preference is related to the need for time-saving.

H2e: Passengers' fare preference is related to the need to save money.

H2f: Passenger's fare preference is related to the need for no lag.

H2g: Passengers' ticket preference is related to the need for fast response time.

H2h: Passenger's ticket preference is related to the need for practicality.

H2i: Passenger's ticket preference is related to the need for trouble-free.

H2j: Passengers' ticket preference is related to the need to protect personal information.

H2k: Passengers' ticket preference is related to the need to protect personal property.

H2l: Passengers' ticket preference is related to the need for a trusted security system.

According to Table 4.8, (1) ticket preference ($p=0.254$, $p>0.05$) did not show correlation with the demand for trusted ticket technology. Therefore, hypothesis H2a was not supported. (2) Ticket preference ($p=0.180$, $p>0.05$) did not show correlation with the demand for trusted ticketing technology. Therefore, hypothesis H2b was not supported. (3) Ticket preference ($p=0.436$, $p>0.05$) did not show correlation with the

demand for trusted metro companies. Therefore, hypothesis H2c was not supported. (4) Ticket preference ($p=0.885$, $p>0.05$) did not show correlation with the need to save time. Therefore, hypothesis H2d was not supported. (5) Gender ($p=0.738$, $p>0.05$) did not show correlation with the need to save money. Therefore, hypothesis H2e was not supported. (6) Ticket preference ($p=0.305$, $p>0.05$) did not show correlation with the need to not get stuck. Therefore, hypothesis H2f was not supported (7) Ticket preference ($p=0.433$, $p>0.05$) did not show correlation with the demand for fast response time. Therefore, hypothesis H2g was not supported. (8) Ticket preference ($p=0.963$, $p>0.05$) did not show correlation with the demand for utility. Therefore, hypothesis H2h was not supported. (9) Ticket preference ($p=0.635$, $p>0.05$) did not show correlation with the demand for trouble-free. Therefore, hypothesis H2iwas not supported. (10) Ticket preference ($p=0.654$, $p>0.05$) did not show correlation with the need to protect personal information. Therefore, hypothesis H2j was not supported. (11) Ticket preference ($p=0.712$, $p>0.05$) did not show a significant difference with the need to protect personal property. Therefore, hypothesis H2k was not supported. (12) Ticket preference ($p=0.995$, $p>0.05$) did not show correlation with the need for a trusted security system. Therefore, hypothesis H2l was not supported.

In conclusion, none of the hypotheses formulated in this study were supported by the findings. The preferred ticket type among passengers did not impact their perceived usefulness of QR tickets. Furthermore, there was no discernible difference in the usefulness demand for QR ticket software between passengers opting for card-based tickets and those choosing cardless tickets, indicating a consistent requirement for QR tickets' usefulness. The study highlights the importance of incorporating ticketing technology and electronic payment providers that enjoy passengers' trust, ensuring time-saving functionality, responsiveness, and reliability of the QR ticketing software. Additionally, safeguarding passengers' personal information and

maintaining a trustworthy security system are crucial aspects to consider in the QR ticketing software.

4.3.2 Perceived ease of use

1)Description

In this study, the 1 main factor of perceived ease of use was designed as a 3-item questionnaire (Table 4.7)

Table 4.7 Describe statistical Perceived ease of use (n=176)

Factor	Item	Mean	Standard Deviation	Evaluation Results
Usability	Simple ticket interface	3.36	1.375	Neutral
	User-friendly payment design	3.34	1.334	Neutral
	Convenient and fast process	3.45	1.401	Agree
	Average of usabilityfactors	3.38	1.37	Neutral
	Average of all factors	3.38	1.37	Neutral

With the data findings presented on the table, most of the item evaluated results were neutral. But with the exception of Convenient and Fast Process, which shows correlations with perceived ease of use. According to the table, the mean value of the scale is 3.38.A score higher than the mean (3.38)means that the item shows significant to the impact and needs to be taken seriously. Moreover, the mean standard deviation of the scale is calculated to be 1.37, Showing a large dispersion of all items, meaning the passengers are divided on the perceived ease of use of the ticketing software, with the main factor affecting passengers' perceived ease of use is usability.These main factors are also consistent with the definition of International Organization for Standardization (2018) and the study of Nourallah (2020). Being that the specific factor is the ease and speed of use, similar to what previous researcher’s finding (Teoh et al., 2013).

In short,passengers need the QR ticket software to be easy to use, consideringthat usability is the main factor affecting the perceived ease of use.

2) Chi-square test

A chi-square test of passenger's ticket preference and passenger perceived ease of use is performed by the statistical analysis software. Hypotheses have been created and then tested based on the results of the chi-square test. The results of the chi-square test and hypothesis testing are shown in Table 4.8.

Table 4.8 The impact of passengers' ticket preference on the choice of perceived ease of use.

Factor	Perceived ease of use					Total	χ^2	*p*	HypothesisTest Results
	strongly disagree	disagree	neutral	agree	strongly agree				
Simple ticket interface									
Card Ticket	18	16	15	35	29	113	2.545	0.637	No relationship
Cardless Ticket	10	10	8	32	16	76			
Total	28	26	23	67	45	189			
User-friendly payment design									
Card Ticket	17	16	18	36	26	113	2.634	0.621	No relationship
Cardless Ticket	8	10	15	30	13	76			
Total	25	26	33	66	39	189			
Convenient and fast process									
Card Ticket	17	15	13	32	36	113	2.218	0.696	No relationship
Cardless Ticket	9	10	12	26	19	76			
Total	26	25	25	58	55	189			

* $p<0.05$ ** $p<0.01$

Hypothesis 3 of this study hypothesizes that there is a relationship between passengers' ticket preferences and passengers' perceived ease of use. More specifically as follow:

H3a: There is a relationship between passengers' ticket preferences and the need for a simple ticketing interface.

H3b: There is a relationship between passengers' ticket preferences and the need for user-friendly payment design.

H3c: There is a relationship between passengers' ticket preferences and the need for a convenient and fast process.

According to Table 4.17, (1) ticket preference ($p=0.637$, $p>0.05$) does not show correlation with the need for a simple ticket interface. Therefore, hypothesis H3a was not supported. (2) Ticket preference ($p=0.621$, $p>0.05$) did not show correlationwith the need for a user-friendly payment design. Therefore, hypothesis H3b was not supported. (3) Ticket preference ($p=0.696$, $p>0.05$) did not show correlation with the need for a convenient and fastprocess. Therefore, hypothesis H3c was not supported.

In summary, passengers' ticket type preferences do not impact the perceived ease of use of QR tickets. Both passengers choosing card-based tickets and those choosing cardless tickets have similar ease-of-use requirements for QR ticketing software.Therefore, the ease-of-use requirements for QR tickets emphasize the importance of a simple and efficient process when using the QR ticket software.

4.4 Conclusion

Based on the analysis findings, the most commonly used e-payment method among BTS Skytrain passengers in their daily lives is mobile banking, and it is also their preferred e-payment method when riding the BTS Skytrain. Currently, passengers demonstrate a higher willingness to use card-based tickets compared to

cardless tickets. Moreover, the level of education influences the intention to use, with higher education levels correlating to a greater acceptance of new cardless ticket options.

The main factors affecting passengers' perceived usefulness of ticketing software are trust and efficiency, while the main factor affecting passengers' perceived ease of use is usability. Interestingly, passengers' ticket type preferences do not affect their need for QR tickets. Passengers express a need for ticketing software that employs trusted ticketing technology and electronic payment providers, ensures time-saving functionality, exhibits responsiveness without lag, protects personal information, and incorporates a reliable security system.

Based on the requirements derived from the analysis, this study will design a prototype of ticketing software that meets the needs of passengers in Chapter 5.

Chapter 5
QR Ticket System Design

This sectionwill be describing the design of QR ticketing software.The section is divided into three parts: conceptual design, prototyping, and testing.

5.1Passenger Demand

BTS Skytrain passengers require a ticketing technology and electronic payment provider that instills trust and reliability. The ticketing software should prioritize efficiency, enabling passengers to save time without experiencing lag or delays. Furthermore, it is crucial that the ticketing software also has ways to protect the passengers' personal information, through a robust security system. Ultimately, providing passengers with an easy and swift ticketing process, ensuring a seamless user experience through reliability and security.

5.2 Conceptual Design

In this section, the researcher combines the passenger needs identified from the analysis conducted in the previous chapter with the insights gathered through document analysis. This combination of information serves as the foundation for designing the concept, functionality, and user flow of the QR ticket system.

5.1.1 Application Software Concept

Table 5.1 Document Analysis

Item	Thailand	China
Percentage of use	Throughout the study, the majority of Thais prefers card tickets, with 40.2% preferring the cardless method	Chinese most commonly use public transit cards, with 36.1% using QR tickets with increasing popularity. The usage rate of QR tickets in Guangzhou reached 74.54% (Fitgroup, 2018).
Passenger Education	Riders of the BTS Skytrain are mainly college and higher educated people who take the train for work travel (Ratanawaraha et al., 2015; Matsuyukiet al., 2020).	Regular commuters are college or higher educated. Moreover, commuters are made up of women, elderly, and commercial service workers in Guangzhou Metro (Ye et al., 2021).
Popular e-payments	After bank transfers, QR code payments are the second most popular electronic payment method in Thailand (2C2P, 2022).	The most popular electronic payment method in China is QR code payment, with over 90% of Chinese using WeChat Pay or Alipay (Klein, 2020)
Metro Problems	During crowded periods, passengers waste a lot of time in buying tickets, toping-up, and queuing, resulting in a poor passengerexperience (Poomrittigul et al., 2019).	QR code tickets used by the Guangzhou Metro can improve efficiency, reduce crowded lines, the hassle of buying and changing tickets, and improve the passenger experience (Tan, 2019; Chen, 2019).

Table 5.1 (Continued)

Metro App	BTS has its own application which helps guides, provides information, and calculates fares for passengers. However, are limited to giving information, and cannot be use for purchasing tickets (BTS, 2023).	Guangzhou Metro application can provide navigation, information, as well as shopping functions. Passengers can also use QR tickets after binding their e-payment account with the application (Guangzhou Metro, 2021).

By combining the passenger demand with related documents in Chapter 4, a comparison can be made between the two systems implemented within their respective country, as listed in Table 5.1. Notably, both BTS and Guangzhou Metro cater to a similar demographic of commuters with a bachelor's degree or higher. It is also evident that card tickets remain the mainstream choice for both countries, with a similar demand present for QR tickets. Among Thai BTS passengers, 40.2% express a willingness to try cardless tickets, while in China, 36.1% of individuals already utilize QR tickets, with Guangzhou accounting for 74.54% of QR ticket users.

Currently, the BTS experiences inconvenience in terms of queuing, ticket purchase, and ticket top-ups during peak hours, while Guangzhou Metro effectively mitigates these issues by implementing QR tickets. Additionally, while both BTS and Guangzhou Metro offer applications that provide navigation and information to passengers, the BTS application lacks ticket purchase options and payment functionality, whereas the Guangzhou Metro supports QR tickets and payment through e-payment account binding.

These findings highlight the striking similarities between metro passengers in China and Thailand regarding ticket preferences, payment methods, and user demographics. Given the success of Guangzhou Metro's utilization of QR tickets

within its application to address the challenges of ticket purchase, toping-up, and queuing during peak hours, it becomes evident that the BTS could also overcome these issues by implementing QR tickets.

In the next section, a redesign of QR code ticket software for the Bangkok Metro mass transit system will be presented, drawing inspiration from the QR code ticket system implemented in the Guangzhou Metro.

5.1.2 Function and flow chart

1) Functions

The QR Ticket application contains the following elements, identified based on the passenger needs.

Registration and login: QR ticket software will be designed to cater to passengers' preferences and prioritize the protection of their personal information.QR ticket software uses email for registration and login. The software also allows the user to connect with their social platform accounts for quick registration.It is important to note that the software will not collect personal data from email or social platform accounts, thus safeguarding passengers' privacy and meeting their requirement for personal information protection.

QR code ticket: The electronic ticket will be presented in the form of a QR code, enabling passengers to scan it for seamless entry and exit at the station. Similar to card-type tickets, the system automatically calculates and deducts the appropriate amount. Also, with Thais already familiar with the QR payment system, the software aligns and will easily be well received and adopted by the passengers. Furthermore, the QR ticket system will prioritize simplicity, convenience, and responsiveness. Passengers will experience a straightforward and user-friendly process, allowing them to swiftly enter the station. Thus, saving them time.

Choose an e-payment method: The QR Ticket Software will provide passengers with the flexibility to select their preferred e-payment method and

providers, including major mobile banks, popular e-wallets, debit cards, and credit cards, ensuring a convenient and personalized experience as well as providing a trustworthiness through the established providers. When purchasing a ticket, the software will automatically deduct the ticket fee from the selected e-payment method, simplifying the payment process.

Payment history inquiry: All passenger payment history, such as payment time and pricewill be available for inquiry.

Refresh tickets: Troubleshooting options and page refreshing are available when experiencing faults such as loading errors.

Language Switching: The QR Ticket software supports Thai and English, with options to switch between the two languages.

Instructions for use: Passengers are introduced to the process and precautions of using the QR ticket.

The process and appearance of the QR Ticker software will be based on the information presented above.

2)Flow Chart

To use the QR Ticket application, users must first sign in or register using their social media accounts before they can access the main ticket page. The main ticket page is composed of five sections: e-payment method selection, QR code ticket, ticket refresh, language switch and instructions.

Upon initial usage of the QR Ticket application, first-time users will be prompted to add and select their desired electronic payment method. Once this step is completed, they can navigate back to the main ticket page to access the QR code ticket. To utilize the QR code ticket, users simply need to align the QR code with the scanning area located at the subway gate. After a successful scan, they will be granted access to enter the station.

Upon leaving, the user repeats the same process of scanning and verification. The system will automatically deduct the applicable fare from the user's chosen electronic payment method, streamlining the payment process.

In the event of any loading issues with the QR code ticket, users will have the option to resolve this by clicking the refresh button. This functionality will enable them to reload the ticket, ensuring a smooth and uninterrupted experience.

For users who wish to review their payment history, a dedicated button will be available within the application. By tapping this button, passengers can conveniently access and view their past payment transactions, providing them with a clear record of their ticket usage.

And lastly, the software comes with the support for both Thai and English, with options that allow users to switch between them within the application, according to their preferences.

The Figure 5.1 below illustrates the flow chart of the ticketing software.

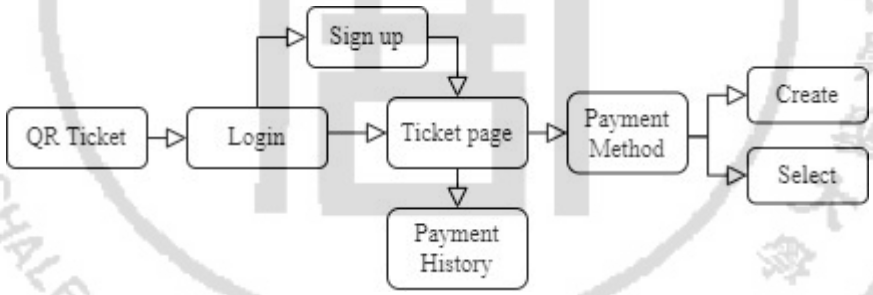


Figure 5.1 Flowchart of QR ticket use

5.3 Prototyping

The QR ticket software prototype was designed based on the aforementionedconcepts of functionalitywith respect to the flowchart. To ensure a simple and convenient design for the ticket application, the following design principles should be followed:

Uniform Color Tone: Ensuring a consistent and appropriate color tone throughout the application to show coherent.

Area of QR Code: The area of the QR code should be clearly visible and appropriately size to improve the success rate of scan.

Fonts and Buttons: Fonts on buttons within the application should be simple and clear. Buttons should be logically positioned and appropriately sized. The design should also allow and be suitable for one-hand operations.

With the provided information, the design below illustrated the concept essential to the design. Figure 5.2 shows the wireframe of the ticketing application. Figure 5.3 shows the prototype of the ticketing application.

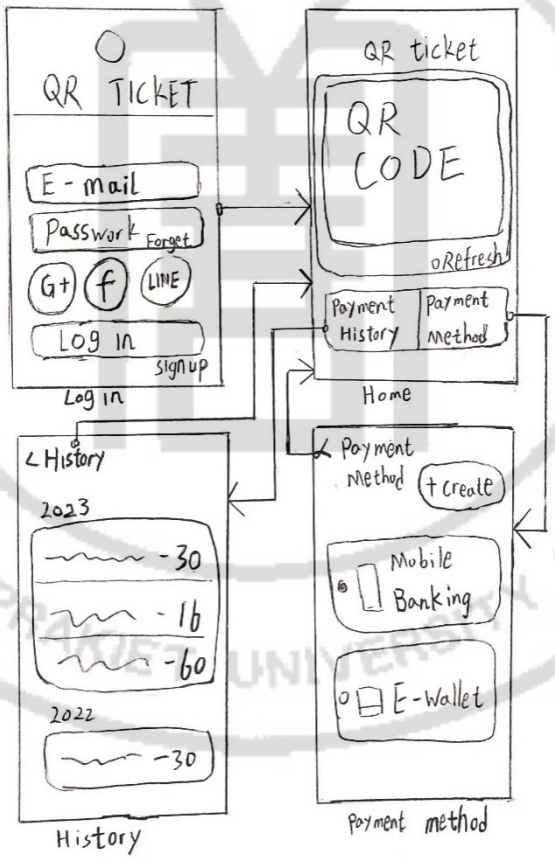


Figure 5.2 QR Ticket Software Wireframe

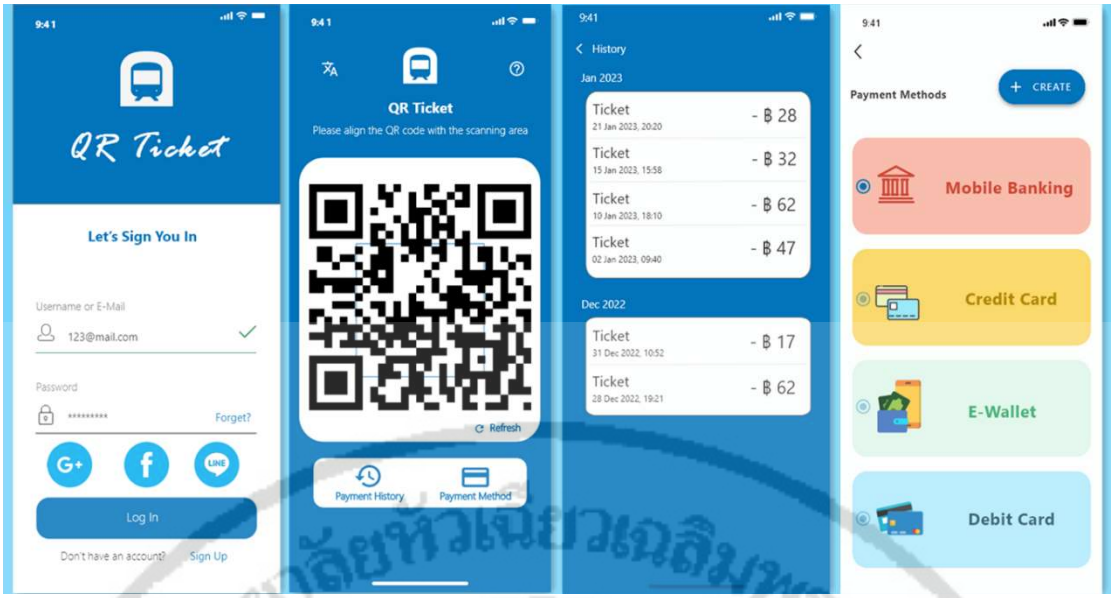


Figure 5.3 QR Ticket Software Prototype

5.4 Evaluation

In this section, the researcher will present an analysis and description of the passengers' evaluation of the QR ticket prototype, as well as their intention to use the software. The analysis is based on the questionnaires collected, with a total of 198 questionnaires collected, of which 175 were deemed valid for analysis. This section can be further divided into three parts: demographic information, QR ticket prototype evaluation, and passengers' intention to use the QR ticket.

5.4.1 QR ticket prototype evaluation

1) Perceptual usefulness evaluation

In this study, the four main factors of perceived usefulness of the QR ticket prototype were designed into 12 evaluation items for the questionnaire (Table 5.2).

Table 5.2 Describe statistical perceived usefulness evaluation (n=175)

Factor	Item	Mean	Standard Deviation	Evaluation Results
Trust	QRcode technology	4.15	0.916	Agree
	E-payment method	4.19	0.876	Agree
	Metro company	4.11	0.931	Agree
	Average of trust factors	4.15	0.908	Agree
Efficiency	Savequeuingtime	4.53	0.787	Definitely agree
	No need to recharge	4.31	0.843	Definitely agree
	Fastride	4.32	0.851	Definitely agree
	Average of efficiency factors	4.39	0.827	Definitely agree
Reliability	Practical	4.29	0.857	Definitely agree
	Lessfailure	3.99	0.944	Agree
	Fast response	4.21	0.930	Definitely agree
	Average of reliability factors	4.16	0.910	Agree
Security	Protects personal information	3.98	0.944	Agree
	Protects personal property	3.92	0.962	Agree
	Secure system	4.07	0.916	Agree
	Average of security factors	3.99	0.941	Agree
	Average of all factors	4.17	0.897	Agree

Data analysis shows that all items in the evaluation questionnaire are at least evaluated as agreeable, with some being above. The survey has shown that respondents have a high opinion of the QR ticket prototype. Based on the analysis of the collected questionnaires, the mean value of the scale is determined to be 4.17. Any sub-items with ratings above 4.17 are considered to be highly rated by the passengers. Referring to Table 5.2, the highest rated factor identified by the respondents is

efficiency, along with its four items, ranked by popularity as follow: Saves queuing time, provide faster rides, does not require top-ups, ticket is practical, ticket is responsive, and that a trusted electronic payment method is present.

In short,riders have provided high ratings for the QR ticket software, particularly in terms of efficiency. For the software, the time-saving aspect along with its ability to facilitate fast rides, no top-up requires, practicality, responsiveness, and incorporation of electronic payment method is highly rated by the passengers.

2) Perceptual ease of use evaluation

In this study, the main factor of perceived ease of use of the QR ticket prototype was designed intothree evaluation items for the questionnaire (Table 5.3).

Table 5.3 Describe statistical Perceived ease of use evaluation (n=175)

Factor	Item	Mean	Standard Deviation	Evaluation Results
Usability	Easy to learn	4.28	0.869	Definitely agree
	Easy to use	4.31	0.888	Definitely agree
	Convenient and fast	4.31	0.850	Definitely agree
	Average of usabilityfactors	4.30	0.869	Definitely agree
Average of all factors		4.30	0.869	Definitely agree

The data analysis reveals that all items in the evaluation questionnaire received strong agreement from the respondents, indicating a positive perception of the perceived ease of use of the QR ticket prototype. With a mean value of 4.30, any items exceeding this value are considered highly rated by the passengers. Referring to

Table 5.3, the highest-rated factor identified by the respondents was usability. Followed by ease of use, and quick and easy to use.

In summary, passengers gave the efficiency and usability of the QR ticketing software high ratings. Moreover, ease of use, ease and speed of using the QR ticket, and perceived ease of use of the QR ticketing software prototype were also highly rated, following efficiency and usability. Table 5.4 illustrates the results of these findings.

Table 5.4 Total average of each evaluation factor

Factor	Average of factors
Trust	4.15
Efficiency	4.39
Reliability	4.16
Security	3.39
Usability	4.30

5.4.3 Intention to use QR ticket prototype

1)Description

In this study, the two main factors affecting passengers' intention to use the questionnaire were designed intoseven items (Table 5.5), of which *perceived usefulness* was divided into 4 items, and *perceived usability of ease of use* was divided into 3 items.

Table 5.5 Describe statistical intention to use (n=175)

Factor	Item	Mean	Standard Deviation	Evaluation Results
Perceived usefulness	Trust	4.21	0.848	Definitely agree
	Efficiency	4.23	0.893	Definitely agree
	Reliability	4.11	0.841	Agree
	Security	4.14	0.899	Agree
	Average of trustfactors	4.17	0.870	Agree
Perceived ease of use	Easy to learn(usability)	4.33	0.826	Definitely agree
	Easy to use (usability)	4.33	0.948	Definitely agree
	User-friendly (usability)	4.39	0.870	Definitely agree
	Average of efficiency factors	4.35	0.881	Definitely agree

The data analysis reveals that all items on the Intention to Use scale received either agreement or strong agreement from the respondents, indicating a positive influence on passengers' intention to use the QR ticketing software. The mean score for perceived usefulness is 4.17, while the mean score for perceived ease of use is 4.35.Items with mean scores exceeding 4.17 for perceived usefulness and 4.35 for perceived ease of use indicate a higher level of influence.

According to Table 4.5, trust and efficiency were identified as important factors influencing perceived usefulness, while user-friendliness was found to have a significant impact on perceived ease of use. Therefore, trust and efficiency affect passengers' perception of usefulness, and user-friendliness influences their perception of usability, thus contributing to the overall perceived ease of use.

In short, both perceived usefulness and perceived ease of use affect passengers' intention to use QR ticketing software.Trust and efficiency are the main factors affecting perceived usefulness, while usability is the main factor affecting perceived ease of use.

2)Multiple linear regression analysis

In the upcoming analysisa linear regression will be conducted to examine the relationship between passenger demographic variables and their intention to use the QR ticketing software. Hypotheses will be formulated and tested based on the results obtained from the statistical analysis software.In general, the results are considered statistically significant, and the null hypothesis is rejected when the p-value of the sample data is less than a specific threshold or significant level of 0.01, 0.05, and 0.10 (Maneejuk et al., 2021).

To facilitate the analysis and interpretation of the results, 0.10 was chosen as the significant level in this study. In other words, when the significance of the sample is below 0.10, it means that there is at least one significant effect to be observed.

Hypothesis 4 of this study hypothesizes that passenger demographic variables influence passengers' intention to use the QR ticketing software. More specifically as follow:

H4a: Demographic variables influence the perception of trust in perceived usefulness.

H4b: Demographic variables influence the perceived efficiency in perceived usefulness.

H4c: Demographic variables influence perceived reliability in perceived usefulness.

H4d: Demographic variables influence perceived safety in perceived usefulness.

H4e: Demographic variablesinfluencethe perception of ease of learning in perceived ease of use.

H4f: Demographic variables influencethe perceived ease of use in perceived ease of use.

H4g: Demographic variables have an impact on the perception of user-friendliness in perceived ease of use.

In the regression analysis, the demographic variables (gender, education level, and occupation) were chosen as independent variables, and perceived trust in perceived usefulness was selected as the dependent variable. The results of the analysis presented in Table 5.6 show several key points.

Firstly, the p-value of the F-test is 0.056, which is below the hypothesizedchosen significance level of 0.10, rejecting the hypothesis since there linear relationship was present between the variables.

Secondly, the value of R^2 from the result is 0.043, indicating that the demographic variables can accept 4.3% of perceived usefulness in the trust perception variables.

Thirdly, the variance inflation factor (VIF) for all variables is less than 10, indicating the absence of covariance issues in the model. This suggests that the model is well-constructed.

Fourth, the significant value of occupation is 0.061, which shows significant effect since $p < 0.1$.

Lastly, with all other variables scored greater than 0.1, the unstandardized coefficient of occupation is 0.244, which implies that occupation is positively related to perceived trust in perceived usefulness, and therefore occupation has a significant positive impact on perceived trust in perceived usefulness. Because of that, the hypothesis "H4a: Demographic variables have an effect on perceived trust in perceived usefulness" was accepted.

Regarding the analysis, the regression equation used is as follow:

y=3.35 + 0.174*Gender+0.119*Education Level+0.244*Occupation.

Table 5.6 Trust regression results (n=175)

Model	Unstandardized Coefficients		Standardized Coefficients	t	P	VIF	R^2	Adjusted R^2	F
	B	Std. Error	Beta						
(Constant)	3.35	0.331	-	10.132	0.000	-			
Gender	0.174	0.129	0.103	1.35	0.179	1.034			
Education	0.119	0.098	0.091	1.217	0.225	1.002	0.043	0.026	F=2.571 P=0.056*
Occupation	0.244	0.129	0.143	1.886	0.061*	1.032			

* $p<0.05$ ** $p<0.01$

Throughout the analysis, the independent variables were kept constant while the dependent variable was replaced with perceived efficiency perception in perceived usefulness for regression analysis, with the result shown in Table 5.7 providing several key points as follow:

Firstly, the p-value of F-test scored at 0.080, which rejected the original hypothesis that the regression coefficient was 0 ($p < 0.1$) and was proven significantas linear relationship were presented.

Secondly, the R^2 value of 0.039 indicates that the demographic variables can account for approximately 3.9% of the perceived efficiency perception in perceived usefulness.

Thirdly, the variance inflation factor (VIF) for all variables is less than 10, indicating the absence of covariance issues in the model. This suggests that the model is well-constructed.

Fourth, the significance values of all demographic variables are greater than 0.1,

Fifth, gender, education level, and occupation do not present significance to the result even with the unstandardized coefficients at the score of 0.196, 0.159 and 0.188. Still, all demographic variables have a positive effect on the perceived efficiency in perceived usefulness. Because of that, the hypothesis "H4b: Demographic variables have an effect on perceived efficiency in perceived usefulness" was accepted.

Regarding the analysis, the regression equation used is as follow:

y=3.334+0.196*Gender+0.159*Education Level+0.188*Occupation.

Table 5.7 Efficiency regression results(n=175)

Model	Unstandardized Coefficients		Standardized Coefficients	t	P	VIF	R^2	Adjusted R^2	F
	B	Std. Error	Beta						
(Constant)	3.334	0.349	-	9.554	0.000	-	0.039	0.022	F=2.287 P=0.080*
Gender	0.196	0.136	0.109	1.435	0.153	1.034			
Education	0.159	0.104	0.115	1.537	0.126	1.002			
Occupation	0.188	0.137	0.105	1.374	0.171	1.032			

* $p<0.05$ ** $p<0.01$

Based on the regression analysis, the independent variable was kept constant while the dependent variable was replaced with perceived reliability perception in perceived usefulness, with the results shown in Table 5.8 providing key points as follow:

Firstly, the p-value of F-test scored at 0.070, which rejected the original hypothesis that the regression coefficient was 0 ($p < 0.1$) and was proven significantas linear relationship were presented.

Secondly, the R^2 value of 0.04 indicates that the demographic variables can account for approximately 4% of the perceived reliability in perceived usefulness.

Thirdly, the variance inflation factor (VIF) for all variables is less than 10, indicating the absence of covariance issues in the model. This suggests that the model is well-constructed.

Fourth, the significance value of gender is 0.053, which shows significant effect comparing to other items ($p < 0.1$), while all other variables are greater than 0.1. Meanwhile, the unstandardized coefficient of gender is 0.249. Combining the two piece of information, an implication can be made that gender is positively correlated to the perception of trust in perceived usefulness.Therefore gender can have a significant positive impact on the perception of reliability in perceived usefulness. Because of that, the hypothesis "H4c: Demographic variables have an effect on perceived reliability in perceived usefulness" was accepted.

Regarding the analysis, the regression equation used is as follows:

y=3.293+0.249*Gender+0.1*Education Level+0.159*Occupation.

Table 5.8 Reliability regression results(n=175)

Model	Unstandardized Coefficients		Standardized Coefficients	t	P	VIF	R^2	Adjusted R^2	F
	B	Std. Error	Beta						
(Constant)	3.293	0.328	-	10.035	0.000	-			
Gender	0.249	0.128	0.148	1.947	0.053*	1.034			
Education	0.100	0.097	0.077	1.031	0.304	1.002	0.04	0.024	F=2.398 P=0.070*
Occupation	0.159	0.129	0.094	1.237	0.218	1.032			

* $p<0.05$ ** $p<0.01$

Based on the information provided by the analysis, the independent variable was kept constant while the dependent variable was replaced with perceived safety perception in perceived usefulness. The results are shown in Table 5.9 with some key finding as follow:

Firstly, p-value of the F-test was 0.151, which correlates with the hypothesis given that the regression coefficient was 0 ($p > 0.1$). The hypothesis proves the value to be insignificant and present no linear relationship

Secondly, the value of R^2 is 0.03, indicating that the demographic variables can account for 3% of the perceived usefulness in the perception of security perception variables.

Thirdly, VIF for all variables is less than 10. Given that information, the model proves to have no co-linearity problems, the model is well constructed. Therefore, the hypothesis "H4d: demographic variables have an effect on perceived safety in perceived usefulness" was rejected.

Table 5.9 Security regression results(n=175)

Model	Unstandardized Coefficients		Standardized Coefficients	t	P	VIF	R^2	Adjusted R^2	F
	B	Std. Error	Beta						
(Constant)	3.438	0.353	-	9.744	0.000	-			
Gender	0.259	0.138	0.144	1.883	0.061*	1.034	0.03	0.013	F=1.79 P=0.151
Education	0.057	0.105	0.041	0.546	0.586	1.002			
Occupation	0.128	0.138	0.071	0.928	0.355	1.032			

* $p<0.05$ ** $p<0.01$

Throughout the analysis, the independent variables were kept constant while the dependent variable was replaced with perceived ease of learning in perceived ease of use. The results are shown in Table 5.10, providing several key points as follow:

Firstly, the p-value of F-test scored at 0.070, which rejected the original hypothesis that the regression coefficient was 0 ($p < 0.1$) and was proven significant. Linear relationships were also presented.

Secondly, the R^2 value of 0.037, indicates that the demographic variables can account for approximately 3.7% of the perceived ease of learning perceptual variables in the perceived ease of learning.

Thirdly, VIF for all variables is less than 10, indicating the absence of covariance issues in the model. This also suggests that the model is well-constructed.

Fourth, the significance value of education level is 0.095, while the significance value of occupation is 0.058, with the significant effect ($p < 0.1$), given that the gender variable is greater. Meanwhile, the unstandardized coefficient of education was 0.161 and the unstandardized coefficient of occupation was 0.242.Implications can be made that education level and occupation are positively related to perceived ease of learning in perceived ease of use, and therefore education level and occupation have significant positive effects on perceived ease of learning in perceived ease of use, with occupation having the greatest effect. Therefore, the hypothesis "H4e: Demographic variables have an effect on perceived ease of learning in perceived ease of use" was accepted.

Regarding the analysis, the regression equation is as follow:

y = 3.606 + 0.033 * Gender + 0.161 * Education Level + 0.242 * Occupation.

Table 5.10 Easy-to-learn (Usability) regression results(n=175)

Model	Unstandardized Coefficients		Standardized Coefficients	t	P	VIF	R^2	Adjusted R^2	F
	B	Std. Error	Beta						
(Constant)	3.606	0.323	-	11.166	0.000	-	0.037	0.021	F=2.219 P=0.088*
Gender	0.033	0.126	0.02	0.261	0.794	1.034			
Education	0.161	0.096	0.126	1.677	0.095*	1.002			
Occupation	0.242	0.127	0.146	1.97	0.058*	1.032			

* $p<0.05$ ** $p<0.01$

In this analysis case, the independent variable was kept constant while the dependent variable was replaced with perceived ease of use perception in perceived ease of use, and the results are shown in Table 5.11, where key findings are presented as follow:

Firstly, the p-value of the F-test was 0.212, which did not allow for any rejection of the original hypothesis suggesting that the regression coefficient was 0 ($p > 0.1$). No significance and relationship were found with the given result.

Secondly, the R^2 value is 0.026,indicating that the demographic variables are accounting for up to 2.6% of the perceived ease of use perception variables in perceived ease of use.

Thirdly, VIFvalue is less than 10, indicating that there is no co-linearity in the model, hence, the model is well constructed.Also, significant values of all demographic variables are greater than 0.1.

Given all the presented findings, hypothesis "H4f: Demographic variables have an effect on the perceived ease of perceived ease of use" was rejected.

Table 5.11 Easy-to-use (Usability) regression results (n=175)

Model	Unstandardized Coefficients		Standardized Coefficients	t	P	VIF	R^2	Adjusted R^2	F
	B	Std. Error	Beta						
(Constant)	3.555	0.373	-	9.533	0.000	-	0.026	0.009	F=1.518 P=0.212
Gender	0.161	0.146	0.085	1.104	0.271	1.034			
Education	0.178	0.111	0.121	1.604	0.111	1.002			
Occupation	0.114	0.146	0.060	0.779	0.437	1.032			

* $p<0.05$ ** $p<0.01$

In this analysis, the independent variables were kept constant while the dependent variable was replaced with user-friendly perception in perceived ease of use for. The results are shown in Table 5.12, where key findings are as follow:

Firstly, the p-value of F-test was 0.378, which could not reject the original hypothesis given that the regression coefficient was 0 ($p > 0.1$). No significance and relationship were found with the given result.

Secondly, theR^2 value is 0.018, indicating that the demographic variables account for 1.8% of the user-friendly perception variables in perceived ease of use.

Thirdly, VIFvalue is less than 10, indicating that there is no co-linearity in the model, hence, the model is well constructed.Also, significant values of all demographic variables are greater than 0.1.

Therefore, the hypothesis "H4g: Demographic variables have an effect on user-friendly perceptions in perceived ease of use friendliness" was rejected.

Table 5.12 User-Friendly (Usability) Regression Results(n=175)

Model	Unstandardized Coefficients		Standardized Coefficients	t	P	VIF	R^2	Adjusted R^2	F
	B	Std. Error	Beta						
(Constant)	3.805	0.344	-	11.071	0.000	-			
Gender	0.129	0.134	0.074	0.961	0.338	1.034	0.018	0.001	F=1.035 P=0.378
Education	0.130	0.102	0.097	1.275	0.204	1.002			
Occupation	0.088	0.135	0.051	0.656	0.512	1.032			

* $p<0.05$ ** $p<0.01$

In summary, the analysis indicates that passenger demographic variables have an impact on their intention to use the QR ticketing software. Specifically, passengers' occupation influences their perception of trust in perceived usefulness, while gender, education level, as well as occupation affect the perceived efficiency in perceived usefulness. Gender also influences the perception of reliability in perceived usefulness, while education level and occupation impact the perception of ease of learning in perceived usefulness, reflecting their influence on usability in perceived usefulness.

Overall, passengers' intention to use the QR ticket software is influenced by demographic variables, with trust, efficiency, reliability, and usability being the main factors that play a significant role.

5.5 Conclusion

Throughout the section, a new QR ticket for the Bangkok metro mass transit system in Thailand has been designed, taking into account the needs of passengers and the QR ticket system implemented by the Guangzhou metro. The flow of using the new QR ticket is depicted in Figure 5.1, while Figures 5.2 and 5.3 illustrate the prototype of the QR ticket, showcasing its functions and appearance.

The questionnaires were also designed and evaluated the ratings of the use of QR tickets, in which it received high ratings. Passengers are satisfied with the advantages offered by the QR ticket, such as saving time spent in queues, facilitating fast subway rides, eliminating the need for ticket top-ups, offering practicality, ensuring fast response times, and providing a trusted electronic payment method. The QR ticket is also regarded as easy to use and convenient for quick transactions.

Moreover,as a key finding of the study, trust and efficiency affect perceived usefulness and usability affects perceived ease of use, affecting passengers' intention to use QR tickets. Additionally, demographic variables also influence trust, efficiency,

reliability, and usability. Lastly, the QR ticket software prototype successfully meets the needs of passengers and has received a high rating.

Chapter 6
Conclusion and Suggestions

The section has been divided into two parts, comprising of the summary and the recommendations of this study. The recommendations can be further subdivided into two parts, one for the participants and the other for future researchers.

6.1 Research conclusions

The conclusion of this study can be divided into three parts:Research objectives and research questions, design of the study, and results of the study.

6.1.1 Research Objectives and Research Questions

1) Research Objectives

The objective of this first research istounderstand the needs of passengers of the Bangkok Metro Mass Transit System pertaining to the ticket payment system.The second research objective isto propose a new system that allows passengers to use the QR tickets in the Bangkok Metro Mass Transit System.And lastly, the third research objective isto study passengers' intentions to use the QR tickets in the Bangkok Metro Mass Transit System.

2) Research Questions

The research questions are listed as follow:

1. What are the needs of passengers of the Bangkok Metro Mass Transit System in terms of payment for tickets?
2. What would be the physical appearance of a new system that allows passengers of the Bangkok Metro Mass Transit System to use QR tickets?
3. What is the willingness of passengers to use the QR Tickets in the Bangkok Metro Mass Transit System?

6.1.2 Research Design

This study used a mixed research approach. First, a quantitative method, a survey questionnaire was used to determine the needs of passengers regarding fare payment in the Bangkok metro mass transit system. The data was obtained through a self-selected sampling method, where the study was able to gather a total of 176 valid data points. This data helped identify and clarify the specific requirements of passengers.

Subsequently, came the design of a digital prototype of the ticketing software. Through document analysis, the QR ticket used in the Guangzhou metro was combined with the passenger needs of the Bangkok metro mass transit system to design the prototype of the QR ticket that is for Bangkok.

Finally, passengers were asked to evaluate the digital prototype through a questionnaire. The data was obtained through self-selected sampling and a total of 198 questionnaires were collected, out of which 175 respondents were valid.

Overall, the mixed research approach adopted in this study allowed for a comprehensive understanding of passenger needs, the design of a tailored prototype, and the assessment of its usability and intention to use. The findings serve as a valuable resource for improving passenger experiences and guiding future research endeavors.

6.1.3 Research Findings

1)Answer Research Question 1

Through the questionnaire, it was identified that BTS Skytrain passengers prefer using mobile banking as their preferred electronic payment method within the BTS Skytrain system. But at this stage, the willingness to use card-based tickets is still higher than cardless tickets. However, it was observed that passengers with higher levels of education were more inclined to accept cardless ticketing options. Moreover, passengers also express the need for a trusted e-payment provider and

ticketing technology, along with other areas such as time efficiency, responsiveness, security, and ease of use.

2) Answer Research Question 2

The analysis of the document reveals that the new QR ticket software utilizes QR code technology as a subway ticketing solution. The software offers various electronic payment methods, including mobile banking, e-wallets, credit cards, and debit cards, allowing passengers to conveniently pay for their tickets. Additionally, the software provides additional features such as payment history tracking, language switching, and ticket refreshing in case of error. The ticketing process starts when passengers present their QR code on the software's main page upon entering the station, successfully scanning it for entry, and presenting it again when exiting the station. The software automatically calculates the ticket price and deducts the corresponding amount from the chosen electronic payment method, ensuring a seamless and efficient ticketing experience.

4) Answer Research Question 3

The analysis of the questionnaire results indicates that passengers highly evaluate the QR ticket prototype, which effectively fulfills their needs. The main features offer several advantages, including time-saving benefits by eliminating the need for queuing, providing fast subway rides, and eliminating the requirement for top-ups, as well as practicality, responsiveness, and reliability of the software. Theitionally, the prototype is also user-friendly, ensuring ease of use and convenience for passengers. Moreover, the perceived trust, efficiency, and usability of the QR ticket prototype significantly influences passengers' intention to use the software. Additionally, demographic variables play a role in shaping passengers' perceptions of trust, efficiency, reliability, and usability.

6.2 Suggestion

This section has been divided into two parts, suggestions for BTSSkytrain and suggestions for further research.

6.2.1 Suggestion for BTSSkytrain

The findings of this study reveal that the demand and intention to use QR tickets among passengers of the Bangkok metro mass transit system are influenced by various factors related to perceived usefulness and perceived ease of use. In implementation, these findings are key to metro operators which can use them as a reference in popularizing QR ticketing system.

Passengers' perceived usefulness of QR ticketing software is strongly influenced by the factors of trust and efficiency, which also play a significant role in determining their intention to use it. To meet the passengers' demands, metro companies should prioritize incorporating and partnering withreputable technology and e-payment providers, such as major Thai banks, E-wallets, and credit card issuers. Additionally, it is crucial to ensure that the ticketing software is designed for efficiency and timesaving. This can be achieved by simplifying the ticketing process, utilizing large and visually appealing QR code interfaces for easy recognition, and maintaining a stable system with quick troubleshooting options like refreshing. By addressing these aspects, the QR ticketing software can deliver a seamless and efficient experience, fulfilling passengers' desire for a trusted, time-saving, and fast rides.

Passengers' perceived ease of use of the QR ticketing software is influenced by the factor of usability, which significantly impacts their intention to use it. To cater to passengers' needs, it is crucial to prioritize the design of user-friendly and intuitive ticketing software. The software should feature a simple and straightforward interface with large buttons and clear fonts, ensuring easy navigation and operation for passengers, even with using one-hand. Including instructions and incorporating a

language switch option within the software assists first-time users in quickly familiarizing themselves with QR tickets.

Lastly, the study reveals that while the preference for card-based tickets remains dominant among riders.Insightfully, there is a positive correlation between higher education levels and the acceptance of QR tickets. This suggests that educated riders are more open to embracing new technologies such as QR tickets. In light of these findings, metro operators can focus their promotional efforts on targeting individuals with higher education levels, as they are more likely to accept and adapt to the new QR ticketing system.

6.2.2 Suggestions for Future Research

As a new type of ticket that has not yet been used in Thailand, QR tickets have a lot of room for research and deserve to be further explored by future researchers. Subsequently, the use of QR tickets is not limited to subways, but also applicable to other means of transportation such as buses. Therefore, exploring the acceptance of QR tickets among individuals with lower education levels can provide insights into potential barriers and strategies for promoting inclusivity and accessibility. Moreover, there are still areas that should be further researched, such as the construction of the QR system, the flexibility for the application of the QR system, and the actual efficiency of the QR system.

6.3 Conclusion

This section summarizes the QR ticketing software study alongside answering all research questions regarding the topic of interest. In this study, a new QR ticket software for the Bangkok metro mass transit system was developed based on passenger needs identified through a questionnaire. The evaluations and usage intentions of the QR ticket software were collected, leading to specific comments provided to the metro company to enhance the design and promotion of the software.

Additionally, research recommendations were offered to guide future researchers in areas such as acceptance among individuals with lower education levels, system efficiency, and the application of QR ticketing to other transportation modes.

References

2C2P. (2022). *Popular Payment Methods in Thailand: What Consumers Want.* 2C2P. https://2c2p.com/blog/thailand-payment-methods

Abrazhevich, D. (2001). Classification and characteristics of electronic payment systems. In *International Conference on Electronic Commerce and Web Technologies*(pp. 81-90). Springer, Berlin, Heidelberg.

Abrazhevich, D. (2004). *Electronic payment systems: A user-centered perspective and interaction design.* Dennis Abrazhevich.

Alalwan, A. A., Baabdullah, A. M., Rana, N. P., Tamilmani, K., & Dwivedi, Y. K. (2018). Examining adoption of mobile internet in Saudi Arabia: Extending TAM with perceived enjoyment, innovativeness and trust. *Technology in Society*, *55*, 100-110.

Aldaas, A. (2021). A study on electronic payments and economic growth: Global evidences. *Accounting, 7*(2), 409-414.

Almanasreh, E., Moles, R., & Chen, T. F. (2019). Evaluation of methods used for estimating content validity. *Research in social and administrative pharmacy, 15*(2), 214-221.

AlRefai, Z. A., Muda, H., Siddiqui, A. A., Amin, J., Ilyas, M., & Alam, M. K. (2021). Alternate method of payments and covid-19. *International Medical Journal, 28*(4), 397-399.

Ameerbakhsh, O. Z., Alfadli, I. M., & Ghabban, F. M. (2021). Factors Affecting Saudi Consumers' Acceptance Towards the Use of Electronic Payment. *Design Engineering, 5*, 1212-1224.

Anantsuksomsri, S., & Tontisirin, N. (2015). The impacts of mass transit improvements on residential land development values: Evidence from the Bangkok Metropolitan Region. *Urban Policy and Research, 33*(2), 195-216.

Antwi, S. K., Hamza, K., & Bavoh, S. W. (2015). Examining the effectiveness of electronic payment system in Ghana: the case of e-ZWICH in the Tamale metropolis. *Research Journal of Finance and Accounting, 6*(2), 163-177.

Armey, L. E., Lipow, J., & Webb, N. J. (2014). The impact of electronic financial payments on crime. *Information Economics and Policy, 29*, 46-57.

Arslan, S., Demirel, V., & Kuru, I. (2016). A public transport fare collection system with smart phone based NFC interface. *International Journal of Electronics and Electrical Engineering, 4*(3), 258-262.

Asokan, N., Janson, P., Steiner, M., & Waidner, M. (2000). State of the art in electronic payment systems. *Advances in Computers*, *53*, 425-449.

Baddeley, M. (2004). Using e-cash in the new economy: An economic analysis of micro-payment systems. *Journal of electronic commerce research, 5*(4), 239-253.

Bartin, B., Ozbay, K., & Yang, H. (2018). Evaluation framework for mobile ticketing applications in public transit: a case study. *IET Intelligent Transport Systems, 12*(9), 1166-1173.

Basili, A., Liguori, W., & Palumbo, F. (2014). NFC smart tourist card: Combining mobile and contactless technologies towards a smart tourist experience. In *2014 IEEE 23rd International WETICE Conference* (pp. 249-254). IEEE.

Baždarić, K., Šverko, D., Salarić, I., Martinović, A., & Lucijanić, M. (2021). The ABC of linear regression analysis: What every author and editor should know. European science editing, 47.

Bethlehem, J. (2015). Essay: sunday shopping-the case of three surveys. In *Survey Research Methods* (Vol. 9, No. 3, pp. 221-230).

Bezovski, Z. (2016). The future of the mobile payment as electronic payment system. *European Journal of Business and Management, 8*(8), 127-132.

Bowen, G. A. (2009). Document analysis as a qualitative research method. *Qualitative research journal*.

Bradford, T., Hayashi, F., & Toh, Y. L. (2019). Developments of QR Code-Based Mobile Payments in East Asia. *Federal Reserve Bank of Kansas City, Payments System Research Briefing, June, 18.*

Briggs, A., & Brooks, L. (2011). Electronic payment systems development in a developing country: The role of institutional arrangements. *The Electronic Journal of Information Systems in Developing Countries, 49*(1), 1-16.

BTS. (2022). *How to buy*. รถไฟฟ้าบีทีเอส (BTS Skytrain). Retrieved September 8, 2022, from https://www.bts.co.th/eng/tickets/ticket-machine.html

BTS. (2023). BTS Skytrain - apps on Google Play. Google. Retrieved June 2,2023, fromhttps://play.google.com/store/apps/details?id=com.bts.skytrain&hl=en_US&pli=1

BTSGIF. (2022). *Report of the ridership during the Coronavirus Disease 2019 (COVID-19) outbreak for Aug 2022 BTS Rail Mass Transit Growth Infrastructure Fund.* BTS Rail Mass Transit Growth Infrastructure Fund.

Retrieved October 26, 2022, from https://btsgif.listedcompany.com/newsroom/13092022181311004 9E.pdf

Burkard, S. (2012). Near field communication in smartphones. *Dep. of Telecommunication Systems, Service-centric Networking, Berlin Institute of Technology, Germany.*

Chandra, D. G., Prakash, R., & Lamdharia, S. (2013). Mobile ticketing system for automatic fare collection model for public transport. In *2013 5th International Conference and Computational Intelligence and Communication Networks* (pp. 600-603). IEEE.

Chaokromthong, K., & Sintao, N. (2021). Sample Size Estimation using Yamane and Cochran and Krejcie and Morgan and Green Formulas and Cohen Statistical Power Analysis by G* Power and Comparisions. *Apheit International Journal*, *10*(2), 76-86.

Chawla, D., & Joshi, H. (2017). High versus low consumer attitude and intention towards adoption of mobile banking in India: an empirical study. *Vision, 21*(4), 410-424.

Chen, A. N., Zeltmann, S. M., Griffin, K., Rubach, M., & Ellis, M. E. (2019). Trends and technology in e-Payment. In *Competition Forum* (Vol. 17, No. 2, pp. 402-412). American Society for Competitiveness.

Chen, D. (2019).多元化支付在广州地铁票务系统的应用分析[Application Analysis of Diversified Payment in Guangzhou Metro Ticketing System]. *科技风* (16),74.

Chen, S. C., Shing-Han, L., & Chien-Yi, L. (2011). Recent related research in technology acceptance model: A literature review. *Australian journal of business and management research, 1*(9), 124.

Chi, T. (2018). Understanding Chinese consumer adoption of apparel mobile commerce: An extended TAM approach. *Journal of Retailing and Consumer Services, 44*, 274-284.

China Guangzhou Release. (2017). *全国首个！今天起，广州全线实现微信扫码坐地铁！[The first in the country! From today, the whole line of Guangzhou realize WeChat sweep code to ride the subway!]*. 腾讯网. Retrieved December 6, 2022, from https://new.qq.com/cmsn/20171121/20171121026408.html

Ching, A. T., & Hayashi, F. (2010). Payment card rewards programs and consumer payment choice. *Journal of Banking & Finance, 34*(8), 1773-1787.

Couto, R., Leal, J., Costa, P. M., & Galvão, T. (2015). Exploring ticketing approaches using mobile technologies: QR codes, NFC and BLE. In *2015 IEEE 18th International Conference on Intelligent Transportation Systems* (pp. 7-12). IEEE.

Cudahy, B. J. (1990). *Cash, tokens, and transfers: A history of urban mass transit in North America*.

Davie, G., & Wyatt, D. (2021). Document analysis. In *The Routledge handbook of research methods in the study of religion* (pp. 245-255). Routledge.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS quarterly*, 319-340.

Davis, F. D. (1993). User acceptance of information technology: system characteristics, user perceptions and behavioral impacts. *International journal of man-machine studies, 38*(3), 475-487.

Di Pietro, L., Mugion, R. G., Mattia, G., Renzi, M. F., & Toni, M. (2015). The integrated model on mobile payment acceptance (IMMPA): an empirical application to public transport. *Transportation Research Part C: Emerging Technologies, 5*6, 463-479.

Doan, N. (2014). Consumer adoption in mobile wallet: a study of consumers in Finland.

Egis. (2022). *Bangkok metro lines: End-to-end rail services*. Egis. Retrieved December 15, 2022, from https://www.egis-group.com/projects/bangkok-metro

Ferreira, M. C., Costa, V., Dias, T. G., & e Cunha, J. F. (2017). Understanding commercial synergies between public transport and services located around public transport stations. *Transportation research procedia, 27*, 125-132.

Fishbein, M., Ajzen, I., & Belief, A. (1975). Intention and Behavior: An introduction to theory and research.

Fitgroup. (2018). 《国人智慧出行报告》：深圳、广州和西安腾讯乘车码使用率最高.[Report on the intelligent travel of the Chinese people: Shenzhen, Guangzhou and Xi'an have the highest usage rate of Tencent's ride code] 移动支付网. Retrieved June 2,2023, from https://m.mpaypass.com.cn/news/201810/21115229.html

Fonchamnyo, D. C. (2013). Customers' perception of e-banking adoption in Cameroon: an empirical assessment of an extended TAM. *International journal of economics and finance, 5*(1), 166-176.

Fontes, T., Costa, V., Ferreira, M. C., Shengxiao, L., Zhao, P., & Dias, T. G. (2017). Mobile payments adoption in public transport. *Transportation Research Procedia, 24*, 410-417.

Fraszczyk, A., Magalhaes Da Silva, J., Gwóźdź, A., & Vasileva, G. (2014). Metro as an example of an urban rail system. Four case studies from Europe. *Transport Problems, 9*.

Gu, J. C., Lee, S. C., & Suh, Y. H. (2009). Determinants of behavioral intention to mobile banking. *Expert Systems with Applications, 36*(9), 11605-11616.

Guangzhou metro. (2021). *购票程序 [Ticketing procedure]*. 广州地铁. https://cs.gzmtr.com/ckfw/pwzy_202001/202011/t20201117_69745.html

Guttmann, R. (2002). *Cybercash: the coming era of electronic money*. Springer.

Hanzaee, K. H., & Alinejad, S. (2012). An investigation about customers perceptions of security and trust in e-payment systems among Iranian online consumers. *Journal of Basic and Applied Scientific Research, 2*(2), 1575-158.

Harris, H., Guru, B. K., & Avvari, M. V. (2011). Evidence of firms' perceptions toward Electronic Payment Systems (EPS) in Malaysia. *International Journal of Business and Information, 6*(2), 226.

Hascaryani, T. D. (2013). Analisis Faktor Yang Mempengaruhi Preferensi dan Aksesibilitas Terhadap Penggunaan Kartu Pembayaran Elektronik. *Jurnal Ilmiah Mahasiswa FEB, 2*(2).

Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. *MIS quarterly*, 75-105.

Hidayanto, A. N., Hidayat, L. S., Sandhyaduhita, P. I., & Handayani, P. W. (2015). Examining the relationship of payment system characteristics and behavioural intention in e-payment adoption: a case of Indonesia. *International Journal of Business Information Systems, 19*(1), 58-86.

Intarot, P., & Beokhaimook, C. (2018). Influencing factor in e-wallet acceptant and use. *International Journal of Business and Administrative Studies, 4*(4), 167-175.

International Organization for Standardization. (2018). *ISO 9241-11:2018(en) Ergonomics of human-system interaction — Part 11: Usability: Definitions and concepts. ISO.* Retrieved October 26, 2022, from https://www.iso.org/obp/ui/#iso:std:iso:9241:-11:ed-2:v1:en

Isaac, J. T., & Sherali, Z. (2014). Secure mobile payment systems. *It professional, 16*(3), 36-43.

Israel, G. D. (1992). Determining sample size.

Joshi, A., Kale, S., Chandel, S., & Pal, D. K. (2015). Likert scale: Explored and explained. *British journal of applied science & technology, 7*(4), 396.

Kaewratsameekul, W. (2018). An examination of behavioral intention to use contactless mobile payment: Rapid transit system in Thailand. *Science, Engineering and Health Studies*, 85-101.

Kakizaki, I. (2014). *Trams, buses, and rails: the history of urban transport in Bangkok, 1886-2010*. Silkworm Books.

Karaci, A. (2016). Investigation of attitudes towards computer programming in terms of various variables. *International Journal of Programming Languages and Applications, 6*(1/2), 1-9.

Kaur, K., & Pathak, A. (2015). E-payment system on e-commerce in India. *International Journal of Engineering Research and Applications, 5*(2), 79-87.

Khan, B. U. I., Olanrewaju, R. F., Baba, A. M., Langoo, A. A., & Assad, S. (2017). A compendious study of online payment systems: Past developments, present impact, and future considerations. *International journal of advanced computer science and applications, 8*(5).

Kim, C., Tao, W., Shin, N., & Kim, K. S. (2010). An empirical study of customers' perceptions of security and trust in e-payment systems. *Electronic commerce research and applications, 9*(1), 84-95.

King, D. N., & King, D. N. (2004). *Introduction to e-commerce*. Prentice Hall.

King, W. R., & He, J. (2006). A meta-analysis of the technology acceptance model. *Information & management, 43*(6), 740-755.

Klein, A. (2020). China's digital payments revolution. Brookings Institution, Washington

Kobsa, A. (2001). Generic user modeling systems. *User modeling and user-adapted interaction, 11*(1), 49-63.

Kobsa, A. (2002). Personalized hypermedia and international privacy. *Communications of the ACM, 45*(5), 64-67.

Kumar, A. (2019). A Study of Significant Characteristics of E-payment Regime in India. *MERC Global's International Journal of Management, 7*, 168-174.

Lacmanović, I., Radulović, B., & Lacmanović, D. (2010). Contactless payment systems based on RFID technology. In *The 33rd International Convention MIPRO* (pp. 1114-1119). IEEE.

Lai, P. C., & Lim, C. S. (2019). The effects of efficiency, design and enjoyment on single platform e payment. *Research in Business and Management, 6*(2), 1-16.

Leesa-nguansuk, S. (2022). *Study: Thailand a global leader in real-time payments.*Bangkok post. Retrieved August 21, 2022, from https://www.bangkokpost.com/business/2326473/study- thailand-a-global-leader-in-real-time-payments

Leng, X. (2009). Smart card applications and security. *information security technical report, 14*(2), 36-45.

Leong, L. Y., Hew, T. S., Ooi, K. B., & Wei, J. (2020). Predicting mobile wallet resistance: A two-staged structural equation modeling-artificial neural network approach. *International Journal of Information Management, 51*, 102047.

Li, R., Chung, T. L. D., & Fiore, A. M. (2017). Factors affecting current users' attitude towards e-auctions in China: An extended TAM study. *Journal of Retailing and Consumer Services, 34*, 19-29.

Liébana-Cabanillas, F., Ramos de Luna, I., & Montoro-Ríos, F. J. (2015). User behaviour in QR mobile payment system: the QR Payment Acceptance Model. *Technology Analysis & Strategic Management, 27*(9), 1031-1049.

Liu, M. (2008). *当代北京公共交通史话[The History of Public Transportation in Contemporary Beijing]*. 当代中国出版社.

Liu, T. L., Lin, T. T., & Hsu, S. Y. (2022). Continuance Usage Intention toward E-Payment during the COVID-19 Pandemic from the Financial Sustainable Development Perspective Using Perceived Usefulness and Electronic Word of Mouth as Mediators. *Sustainability, 14*(13), 7775.

Loo, B. P., & Li, D. Y. (2006). Developing metro systems in the People's Republic of China: Policy and gaps. *Transportation, 33*(2), 115-132.

Lopes, A., & Reis, L. (2020). SOCIAL ENGINEERING AND INFORMATION AND COMMUNICATION TECHNOLOGIES. *LIMEN 2020*, 185.

Lwoga, E. T., & Lwoga, N. B. (2017). User acceptance of mobile payment: the effects of user-centric security, system characteristics and gender. *The Electronic Journal of Information Systems in Developing Countries, 81*(1), 1-24.

Ma, Q., & Liu, L. (2004). The technology acceptance model: A meta-analysis of empirical findings. *Journal of Organizational and End User Computing (JOEUC), 16*(1), 59-72.

Mahapatra, D. M., & Patra, S. K. (2016). Payments and Banking with Mobile Devices: A study of E-Wallet and Apps with Pragmatic view. *JIM QUEST, 12*(2), 51.

Maneejuk, P., & Yamaka, W. (2021). Significance test for linear regression: how to test without P-values?. Journal of Applied Statistics, 48(5), 827-845.

Matsuyuki, M., Aizu, N., Nakamura, F., & Leeruttanawisut, K. (2020). Impact of gentrification on travel behavior in transit-oriented development areas in Bangkok, Thailand. Case Studies on Transport Policy, 8(4), 1341-1351.

Mezghani, M. (2008). Study on electronic ticketing in public transport. *European Metropolitan Transport Authorities (EMTA), 56*, 38.

Mishra, P., Pandey, C. M., Singh, U., Gupta, A., Sahu, C., & Keshri, A. (2019). Descriptive statistics and normality tests for statistical data. *Annals of cardiac anaesthesia, 22*(1), 67.

Mpaypass. (2019). 34 座地铁城市移动支付分析报告*[34 metro cities mobile payment analysis report]*. 移动支付网. Retrieved July 11, 2022, from https://www.mpaypass.com.cn/Download/201908/14164852.html

Mpaypass. (2022). *广东省广州市地铁支持的支付方式[Payment methods supported by Guangzhou Metro in Guangdong Province]*.移动支付网. Retrieved September 8, 2022, from https://www.mpaypass.com.cn/traffic/Traffic_List.asp?id=1

MRT. (2022). *Metro business*. BEM บริษัททางด่วนและรถไฟฟ้ากรุงเทพจำกัด (มหาชน). Retrieved October 26, 2022, from https://metro.bemplc.co.th/?lang=en

Mumtaza, Q. M. H., Nabillah, S. I., Amaliya, S., Rosabella, Y., & Hammad, J. A. (2020). Worldwide mobile wallet: A futuristic cashless system. *Bulletin of Social Informatics Theory and Application, 4*(2), 70-75.

Naeem, M., Hameed, M., & Taha, M. S. (2020). A study of electronic payment system. In *IOP Conference Series: Materials Science and Engineering* (Vol. 767, No. 1, p. 012008). IOP Publishing.

Nourallah, M. (2020). *A mobile bank application loyalty model: The young bank customer perspective* (Doctoral dissertation, Mid Sweden University).

Pal, D., Vanijja, V., & Papasratorn, B. (2015). An empirical analysis towards the adoption of NFC mobile payment system by the end user. *Procedia Computer Science, 69*, 13-25.

Pei, Y., Wang, S., Fan, J., & Zhang, M. (2015). An empirical study on the impact of perceived benefit, risk and trust on e-payment adoption: Comparing quick pay and union pay in China. In *2015 7th international conference on intelligent human-machine systems and cybernetics* (Vol. 2, pp. 198-202). IEEE.

Poomrittigul, S., Koomsubsiri, A., Sasithong, P., Deenuch, D., & Wuttisittikulkij, L. (2019). The simulation of queuing model for Bangkok rapid transit train ticket system using Python. In *2019 34th International Technical Conference on Circuits/Systems, Computers and Communications (ITC-CSCC)* (pp. 1-4). IEEE.

Prayoonphan, F., & Xu, X. (2019). Factors influencing the intention to use the common ticketing system (spider card) in Thailand. *Behavioral Sciences, 9*(5), 46.

Ratanawaraha, A., Chalermpong, S., & Chullabodhi, C. (2015). Walking distance of commuters after modal shift to rail transit in Bangkok. Journal of the Eastern Asia Society for Transportation Studies, 11, 1467-1478.

Rimmer, P. J. (2013).*Rikisha to rapid transit: urban public transport systems and policy in Southeast Asia*. Elsevier.

Sciarelli, M., Prisco, A., Gheith, M. H., & Muto, V. (2021). Factors affecting the adoption of blockchain technology in innovative Italian companies: an extended TAM approach. *Journal of Strategy and Management*.

Shaikh, A. A., & Karjaluoto, H. (2015). Mobile banking adoption: A literature review. *Telematics and informatics, 32*(1), 129-142.

Shao, Z., Zhang, L., Li, X., & Guo, Y. (2019). Antecedents of trust and continuance intention in mobile payment platforms: The moderating effect of gender. *Electronic Commerce Research and Applications, 33*, 100823.

Sharma, G. (2017). Pros and cons of different sampling techniques. *International journal of applied research, 3*(7), 749-752.

Siricharoen, W. V., & Siricharoen, N. (2015). How infographic should be evaluated. In *Proceedings of the 7th International Conference on Information Technology (ICIT 2015)* (pp. 558-564).

Slozko, O., & Pelo, A. (2014). The electronic payments as a major factor for futher economic development. *Economics & Sociology, 7*(3), 130.

Soon, T. J. (2008). QR code. *synthesis journal, 2008*, 59-78.

Statler, S. (2016). Barcodes, QR Codes, NFC, and RFID. In *Beacon Technologies* (pp. 317-331). Apress, Berkeley, CA.

Sumanjeet, M., & Roy, S. (2017). E-commece and Online Payment in The Modern Era. *International Journal of Advanced Research in Computer Science and Software Engineering, 7*(5).

Sürücü, L., & MASLAKÇI, A. (2020). Validity and reliability in quantitative research. *Business & Management Studies: An International Journal, 8*(3), 2694-2726.

Tam, C., & Oliveira, T. (2017). Literature review of mobile banking and individual performance. *International Journal of Bank Marketing.*

Tan, Q. (2019).公共交通购票支付的便利化研究*(硕士学位论文,广东财经大学) [Research on the Convenience of Public Transport Purchase and Payment ——Taking Guang Zhou Metro for Example]*.https://kns.cnki.net/kcms2/article/abstract?v=u1RXSVo1P2aj9Lp2wFtUd3evHQe-rputb87rBzYIM_-gmpqxAJUwPCjFHuvU_Igkzd5_92DEI_L8rQvfPmKn4LxXKQ44_Lu-IXe1PHTbVQ1B4V8PZ0GoCA==&uniplatform=NZKPT&language=CHS

Tarigan, Z., Jonathan, M., Siagian, H., & Basana, S. (2022). The effect of e-WOM through intention to use technology and social media community for mobile payments during the COVID-19. *International Journal of Data and Network Science*, *6*(2), 563-572.

Teoh, W. M. Y., Chong, S. C., Lin, B., & Chua, J. W. (2013). Factors affecting consumers' perception of electronic payment: an empirical analysis. *Internet Research*.

Thangamuthu, A. P. (2020). A survey on various online payment and billing techniques. *Humanities, 7*(3), 86-91.

To, A. T., & Trinh, T. H. M. (2021). Understanding behavioral intention to use mobile wallets in vietnam: Extending the tam model with trust and enjoyment. *Cogent Business & Management, 8*(1), 1891661.

Transport for London. (2022). *Fares*. Transport for London. Retrieved October 18, 2022, from https://tfl.gov.uk/fares/

Tsiakis, T., & Sthephanides, G. (2005). The concept of security and trust in electronic payments. *Computers & Security, 24*(1), 10-15.

Uddin, M. S., & Akhi, A. Y. (2014). E-wallet system for Bangladesh an electronic payment system. *International Journal of Modeling and Optimization, 4*(3), 216.

Vaishnavi, V. K. (2007). *Design science research methods and patterns: innovating information and communication technology*. Auerbach Publications.

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management science, 46*(2), 186-204.

Vinitha, K., & Vasantha, S. (2017). Influence of demographic variables on usage of e-payment system. *Int J Mech Eng Technol (IJMET), 8*, 265-276.

Wang, A., & Zhang, L. (2019). A Study of the Assistant Application for Tourists Taking Metros. *International Journal of Computer and Information Engineering, 13*(2), 55-64.

World Bank Group. (2022). *Covid-19 drives global surge in use of digital payments. World Bank*. Retrieved August 21, 2022, from https://www.worldbank.org/en/news/press-release/2022/06/29/covid-19-drives-global-surge-in-use-of-digital-payments

Yakean, S. (2020). E-Payment System Drive Thailand to be a Cahless Society. *Rev. Econ.Financ, 18*, 87-91.

Ye, C. D., Feng, B. Y., & Dai D. D. (2021). 广州地铁站点交通流特征与居民地铁出行的人群分异.[Traffic Flow of Metro Stations and Population Travel Differentiation in Guangzhou]热带地理(05),918-927.

Yousafzai, S. Y., Foxall, G. R., & Pallister, J. G. (2007). Technology acceptance: a meta-analysis of the TAM: Part 1. *Journal of modelling in management.*

Zandi, M., Singh, V., & Irving, J. (2013). The impact of electronic payments on economic growth. *Moody's Analytics: Economic and Consumer Credit Analytics, 217*(2).

Appendices

Appendix A: Approval of ethical committee

Acquire Knowledge to Serve Society

THE CERTIFICATE OF ETHICAL APPROVAL
(CERTIFICATE OF EXEMPTION)
THE ETHICS COMMITTEE OF RESEARCH
HUACHIEW CHALERMPRAKIET UNIVERSITY

February 22nd, 2023

Project Title	Intention to Use QR Ticket for Metro Mass Transit System in Bangkok
Principal Investigator	Mr. Xie Zehua
Faculty / Program	Master of Business Administration Program in Digital Business

This is to certify that the research project above has been approved in accordance with the Declaration of Helsinki by the Research Ethics Committee at Huachiew Chalermprakiet University.

Signature

(Wirat Tongrod , Ph.D.)
Chairman of the Board
Research Ethics Committee
Huachiew Chalermprakiet University

Approval Date	February 22nd, 2023
Certificate Number	.HCU-EC1326/2566

This approval is valid until 21st February 2025.

Appendix B: RequirementsQuestionnaire

My name is Xie Zehua and I am a graduate student in the Master of Business Administration in Digital Business program at Huachiew Chalermprakiet University. As part of this degree, I am writing a thesis titled Intention of BTS Skytrain Passengers to Use QR Ticket for Metro Mass Transit System in Bangkok. The purpose of these studies is to design a new system that allows passengers of the Bangkok subway mass transit system to use QR tickets and finally to study passengers' willingness to use them. In order to complete this study, BTSSkytrain passengers need to be invited to answer a questionnaire.

The questionnaire is voluntary and if you are willing to answer it means that you have agreed to provide data for this study. This study uses anonymity and your name will not appear in this study. Also, the privacy of the participants will be strictly protected. The data collected will only be used for this study and will only be visible to the researcher and thesis advisor and will not be made public for any commercial purposes. For further information and questions about this project, please contact me at xie490344317@gmail.com.

This questionnaire is divided into three parts, the first part is about customer characteristics, the second part is about electronic payments and types of tickets and the third part is about the impact factor scale. The questionnaire has two impact factor scales, the Perceived Ease of Use Impact Factor scale and the Perceived Usefulness Influence Factor Scale.

Section 1: Please indicate your information by ticking (√) in the box that matches yourinformation

1. What is your gender?

□ Male

□ Female

2. What is your level of education?

□ Below bachelor's degree

□ Bachelor's degree

□ Master's degree and above.

3. What is your occupation?

□ Student

□ Employees

Section 2: Problems with electronic payments

Please check the box that matches your information (√), You can choose more than one answer.

4. What is the most recent electronic payment you have used?

□ Credit card

□ Debit card

□ Smart card

□ Mobile banking

□ E-wallet

5. What kind of electronic payment do you want to use when you ride BTS Skytrain?

□ Credit card

□ Debit card

□ Smart Card

□ Mobile banking

□ E-wallet

6. What type of ticket do you want to use when you ride BTS Skytrain?

□ Card ticket

□ Cardless ticket

Part 3: Influencing Factors Scale

3.1 Please tick the boxes that match your opinion " " √" " (1= strongly disagree; 2= disagree; 3= neutral; 4= agree; 5= strongly agree)

Perceptual usefulness items	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	1	2	3	4	5
Trust affects perceived usefulness					
7. I think a trusted Electronic Payment provider would make it useful to me.					
8. I think trusted ticketing technology would make it useful to me.					
9. I think a trusted metro company would make it useful to me.					
Efficiency affects perceived usefulness					
10. I think a ticket system that saves time would make it useful to me.					
11. I think an electronic payment system that saves me money would make it useful.					
12. I think a ticket system that is not lag would make it useful to me.					
Reliability affects perceived usefulness					
13. I think a ticket system with a fast response time would make me feel it is useful.					

14. I think a practical ticketing system would make me feel it is useful.					
15.I think a trouble-free ticketing system would make me find it is useful.					
Security affects perceived usefulness					
16. I think a ticket system that protects personal information would make it useful to me.					
17. I think an electronic payment system that protects personal property would make it useful to me.					
18. I think a trusted security system would make it useful to me.					

3.2 Please tick the boxes that match your opinion " " √" " (1= strongly disagree; 2= disagree; 3= neutral; 4= agree; 5= strongly agree)

Perceptual Ease of Use items	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
	1	**2**	**3**	**4**	**5**
Usability affects perceived ease of use					
19. I think a simple ticket interface will make it easy to use.					
20. I think the user-friendly payment design will make it easy to use.					
21. I think the convenient and fast process will make it easy to use.					

Thank you very much for your participation.

Appendix C: EvaluationQuestionnaire

Intention to Use QR Ticket for Metro Mass Transit System in Bangkok

My name is Xie Zehua and I am a graduate student in the Master of Business Administration in Digital Business program at Huachiew Chalermprakiet University. As part of this degree, I am writing a thesis titled Intention to Use QR Ticket for Metro Mass Transit System in Bangkok. The purpose of these studies is to design a new system that allows passengers of the Bangkok subway mass transit system to use QR tickets and finally to study passengers' willingness to use them. In order to complete this study, BTSSkytrain passengers need to be invited to answer a questionnaire.

The questionnaire is voluntary and if you are willing to answer it means that you have agreed to provide data for this study. This study uses anonymity and your name will not appear in this study. Also, the privacy of the participants will be strictly protected. The data collected will only be used for this study and will only be visible to the researcher and thesis advisor and will not be made public for any commercial purposes. For further information and questions about this project, please contact me at xie490344317@gmail.com.

This questionnaire is divided into four parts, the first part is choice information, the second part is demographic information, the third part is QR ticket evaluation questions, and the fourth part is QR ticket usage intention questions.

Section 1: Select Information

Please tick (√) the box that matches your information

1. Have you ever taken the BTS Skytrain?

□ Yes

□ No

If your answer is “No”, please stop answering the questionnaires

Section 2: Demographic Information

Please check the box that matches your information (√)

2. What is your gender?

□ Male

□ Female

3. What is your level of education?

□ Below bachelor's degree

□ Bachelor's degree

□ Master's degree and above.

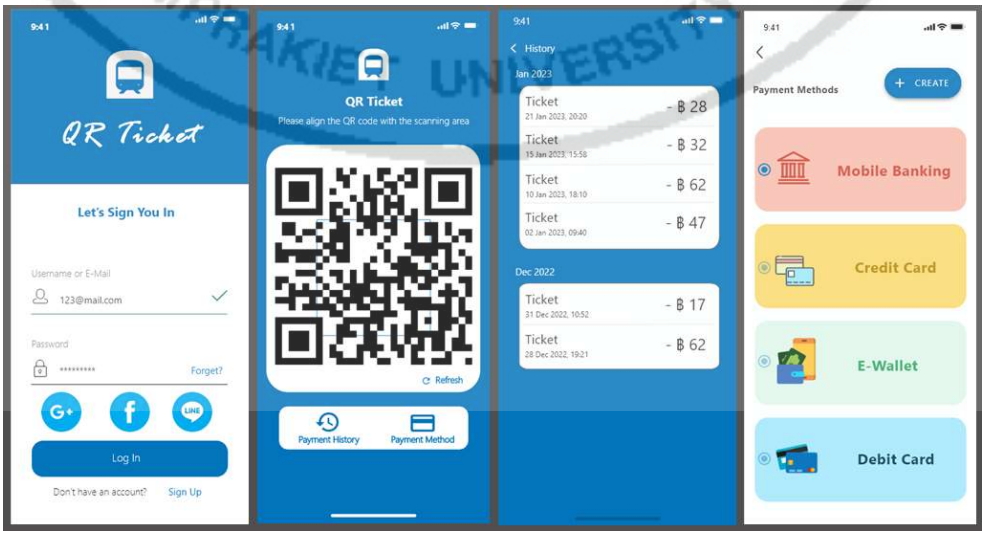
4. What is your occupation?

□ Student

□ Employee

Before answering the next questions, please preview the presentation of the QR ticket software prototype and answer the questions in Section 3 based on your feelings after viewing it.

This is a type of ticket that uses a QR code format, and payment is done through an electronic payment method available within the phone, without requiring passengers to stand in line to buy tickets or top up. When passengers take the train, they simply open the QR ticket software and align the QR ticket on the main page with the scanning area to pass. The QR ticket will automatically deduct the fare after you exit the station successfully, just like a card ticket.



Regarding the QR Ticket software, passengers can register or log in using their social media accounts and email addresses. The main page of the software is QR Ticket, and the page also contains the function of selecting electronic payment methods, checking the payment history and refreshing the function. Passengers can first select the e-payment method they want to add or use: e.g., mobile banking, e-wallet, debit card, and when the passenger successfully leaves the station, the software will automatically calculate the price and deduct it through the relevant e-payment. If a QR ticket loads incorrectly due to network problems, you can click Refresh to reload the QR ticket. Passengers can also view their spending history through the payment history.

Section 3: QR ticket design evaluation

3.1 Please mark "√" in the box that matches your opinion of the QR Ticket software (1= Strongly Disagree; 2= Disagree; 3= Neutral; 4= Agree; 5= Strongly Agree)

Evaluate usefulness	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	1	2	3	4	5
Design for trust					
1. The QR ticket uses QR technology that I trust and that I find useful.					
2. The QR ticket uses an electronic payment method that I trust, making it useful to me.					
3. The QR ticket is used on a mode of transportation that I trust, which makes it useful to me.					
Design for efficiency					
4. QR ticket can make me stop standing in line to buy tickets and make it useful for me.					
5. QR ticket can make me stop recharging my money,					

so I find it useful.					
6. QR ticket can make me ride quickly, so I find it useful.					
Design for reliability					
7. The QR ticket is practical, which makes it useful to me.					
8. The QR ticket is less faulty, which makes it useful to me.					
9. The QR ticket has a fast response time, which makes it useful to me.					
Design for security					
10. The QR ticket will protect my personal information so that I find it useful.					
11. The QR ticket will protect my property so I find it useful.					
12.The security system of the QR ticket makes me find it useful.					

3.2 Please mark " " √" " in the box that matches your opinion of the QR Ticket software (1= Strongly Disagree; 2= Disagree; 3= Neutral; 4= Agree; 5= Strongly Agree)

Evaluate ease of use	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
	1	**2**	**3**	**4**	**5**
Design for usability					
1. The QR ticket is easy to learn, which makes it useful to me.					
2. The QR ticket is easy to use, which makes it useful to me.					
3. The QR ticket can be used quickly, which makes it useful to me.					

Section 4: Intention to use QR ticket

Please mark " " √" " in the box that matches your opinion of the QR Ticket software (1= Strongly Disagree; 2= Disagree; 3= Neutral; 4= Agree; 5= Strongly Agree)

Item	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	1	2	3	4	5
Perceived usefulness					
1. Regarding the trust of QR Ticket Software, I have an intention to use QR tickets.					
2. Regarding the efficiency of QR Ticket Software, I have an intention to use QR tickets.					
3.Regarding the reliability of QR Ticket Software, I have an intention to use QR tickets.					
4.Regarding the security of QR Ticket Software, I have an intention to use QR tickets.					
Perceived ease of use					
5. I want to use QR ticket because it is easy to learn.					
6. I want to use QR Ticket because it is easy to use.					
7. I want to use QR Ticket because it is user-friendly.					

Thank you very much for your participation.

หนังสือยินยอมการเผยแพร่ผลงานวิจัย

Consent form for research dissemination

เขียนที่ At Huachiew Chalermprakiet University

วันที่ Date June/12/2023

ข้าพเจ้า นาย/นาง/นางสาว **Mr**./Mrs./Miss. Xie Zehua **รหัสนักศึกษา Student ID:** 646025-824 **ระดับ level** ☑ ปริญญาโท Master's degree

หลักสูตร Courses: Master of Business Administration **สาขาวิชา field of study:** Digital Business **คณะ Faculty:** Business Administration **Email:** 490344314@qq.com

ชื่อเรื่อง Title (ดุษฎีนิพนธ์/**วิทยานิพนธ์**/การศึกษาอิสระ)

(ชื่อภาษาไทย) (Thai Title) ความตั้งใจให้ผู้โดยสารรถไฟฟ้า BTS Skytrain ใช้ QR Ticket ในระบบขนส่งมวลชนด้วยรถไฟฟ้าในกรุงเทพมหานคร

(ชื่อภาษาอังกฤษ) (English Title) Intention of BTS Skytrain Passengers to Use QR Ticket for Metro Mass Transit System in Bangkok

☑ **อนุญาต** ให้ศูนย์บรรณสารสนเทศ มหาวิทยาลัยหัวเฉียวเฉลิมพระเกียรติ เผยแพร่งานวิจัยของข้าพเจ้าสู่สาธารณะ เพื่อเป็นผลงานทางวิชาการ ผ่านระบบฐานข้อมูลงานวิจัย ThaiLIS

☑ **Permit** the Information Center at Huachiew Chalermprakiet University to publish my research to the public as an academic achievement through the ThaiLIS research database system

☐ **ไม่อนุญาต Not permitted**

ลงชื่อ Sign.....XIE ZEHUA..... Researcher ผู้วิจัย

(MR.XIE ZEHUA)