

**FORECASTING THE DIFFUSION PATTERN: A QR CODE
PAYMENTS IN THAILAND BEYOND 2017**



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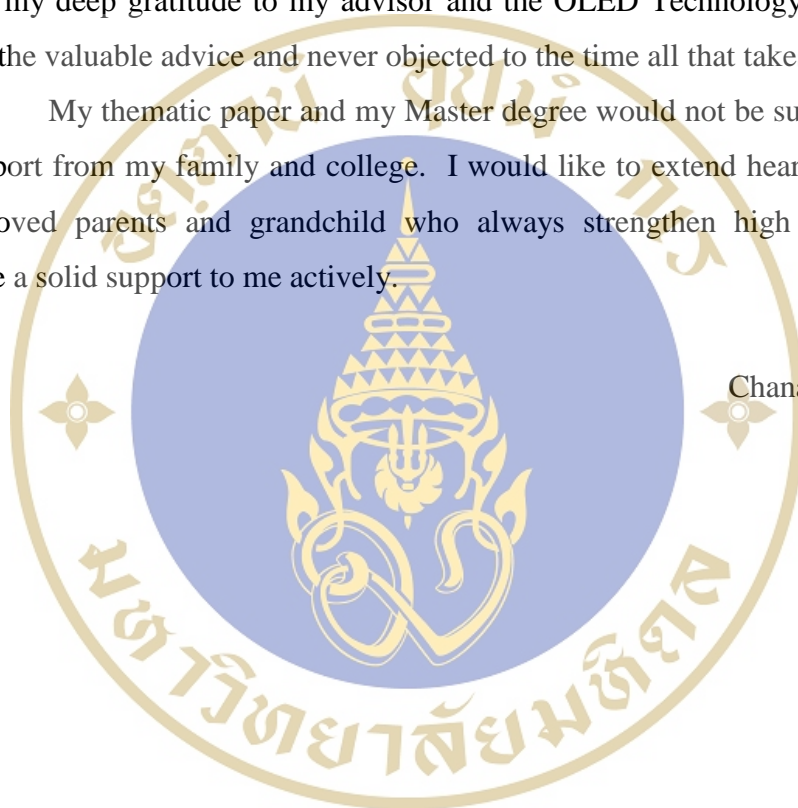
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ABSTRACT

The QR code payment has successful in many countries such as China, India, Japan and Korea while the low success rate also found in some developing countries such as U.S.A., English. In Thailand, the Bank of Thailand announce the Payment Systems Roadmap and Frame Work to establishing the payment systems are efficient, sound and safe and comply with international standards and aim to shift Thailand from cash based to non-cash based society by firstly launching the Prompt Pay service in early of 2017 and will continuing with the QR payment technology. The research target to forecast the diffusion pattern of QR payment in Thailand by using BASS model to forecast the number and adoption time of QR payment in Thailand.

The result of this study shows; QR code payment diffusion pattern has highest adoption during the year 2018 – 2020 with the number of adoption customers with mobile device between 60 – 70 million devices. The result has the mean absolute percentage error (MAPE) at 39% which benefit to the business to prioritize and plan the resource e.g. expertise person in QR code technology, financial in term of investment budget, and time line to implement and promote QR code payment.

KEY WORDS: QR Code Payment / Mobile Banking Payment / BASS Model

37 pages

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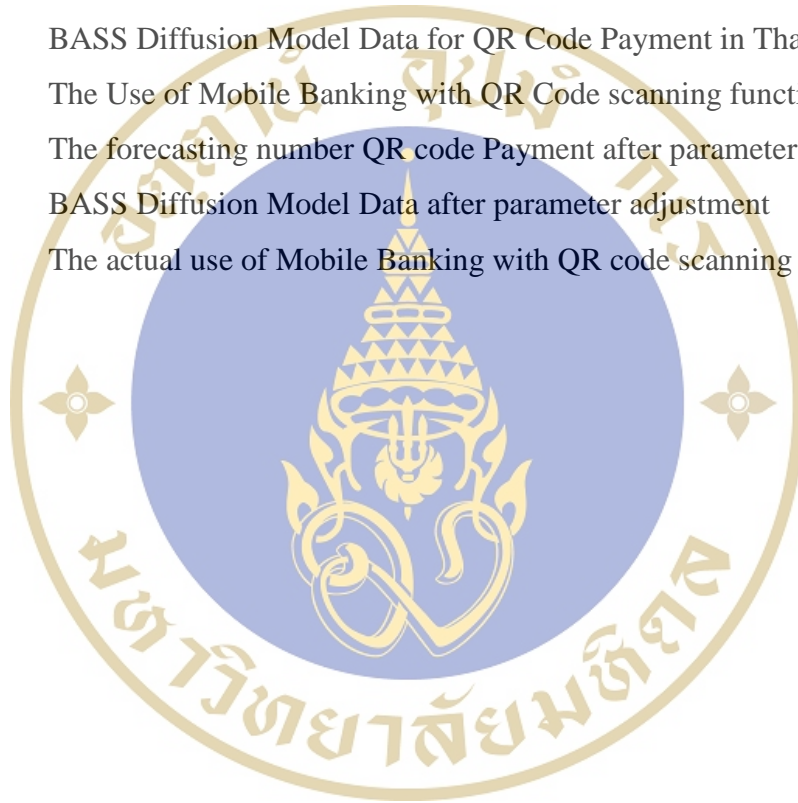
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CHAPTER I

INTRODUCTION

1.1 Background and problem statements

Thailand is the cash based society country, almost of people and business organization perform financial transaction by using cash. In last two decade, it has significantly increasing the number of internet usage and mobile devices which enabling consumers behavior change from cash based transaction to non-cash based in mobile payment world.

According to Ericson mobility report 2016, the number of smart mobile devices around the world will have rapid growth about 1,600 million devices within year 2021 and can connect as Internet of Thing (IoT) devices to communicate, exchange data and response each devices to finish the assigned tasks in automatically mode while the number of smart mobile device with high capability in Thailand will be double digit increasing from 40 million devices in year 2013 to 80 million devices within year 2021. The number of smart mobile devices and function inside reflect directly to the higher capability and portion of consumers which can connect and do transaction online to gain benefit from application in smart mobile device including contact less mobile payment.

The contactless of mobile payment technology including of Near Field Communication (NFC), Quick Response Code (QR) and Short Message Service (SMS) payment. It's involve many parties in the mobile payment landscape including of financial and non- financial institutions, mobile network operators, regulations and consumers (Denis *et al.*, 2015)

According to BCG-Google Digital Payments report 2016, the contact less payments with NFC has not been very successful from the main reasons which is the high cost to embed NFC function in both smart phones and merchant terminals which make high investment to accept NFC device in market. The other form of contact less payment that more effectiveness in new market like China and India could more appraise to consider to roll out. For example of the use of QR Code technology can make point of sale mobile payment convenient. Customer just need to scan the merchant QR code or vice versa, the merchant scan QR code at customer device at the check point and pay the amount by direct debit from wallet/account or pay with credit card such as VISA, Master and Union Pay.

The QR payment in China is very high successful in roll out and usage by Chinese around the country. The Chinese mobile payment with QR code market has grown rapidly and will reach ¥12.2 trillion (US\$1.83 trillion) in year 2016, up from ¥0.2 trillion (US\$31.7 million) in 2012 and the same rapidly growth trend of QR code payment occurring in India, according to iResearch Mobile Payments report, 2016.

Today in Thailand, the Prompt Pay project already roll out as one of the main task following Thailand Payment Roadmap which target to turn Thailand Economy to be Cashless Ecosystem. The payment roadmap including many tasks such as Prompt pay infrastructure implementation, Electronic Data Capture (EDC) roll out to merchants and etc., While QR code payment technology is another next action in the plan. Thus, we would like to forecast of diffusion pattern for the new technology QR code payment which will benefit to the business organization for investment and resource preparation to response on QR code payment adoption in Thailand.

1.2 Research Objectives

The primary objective of this thematic paper is to identify the proper method and analogous technology which can use to forecast the diffusion pattern of QR code payment technology in Thailand.

1.3 Contribution of Study

In the business competition way, trying to get the advantage from forecasting on what will happened in the future and work backward to identify the strategy and prioritize the resource e.g. financial, people, partner and etc. to focus on key strategic product to be launch on the right time.

A diffusion model produce a life-cycle adoption curve based on a small number of parameters which could be estimated by analogy to the histories of similar new technology introduce to the market in the past to answer how many customers will eventually adopt the new technology and when.

In contradict, on this research, author tries to identify analogy technology similarly to QR code payment, identify the parameter and value put to the acceptable forecasting model and provide the diffusion pattern of QR code technology in Thailand for business benefit to understand the diffusion pattern of QR code payment technology and have proper plan to invest resource by not over investment or under investment and get a better chance of success from new technology come in.

CHAPTER II

LITERATURE REVIEW

2.1 Thailand Payment Systems Roadmap

According to BOT Payment Systems Roadmap 2012-2016 report, “*The Roadmap will be used as a framework for Thailand’s payment systems developing during 2012-2016 with the aim of establishing payment systems that are efficient, sound and safe, as well as comply with international standards*”

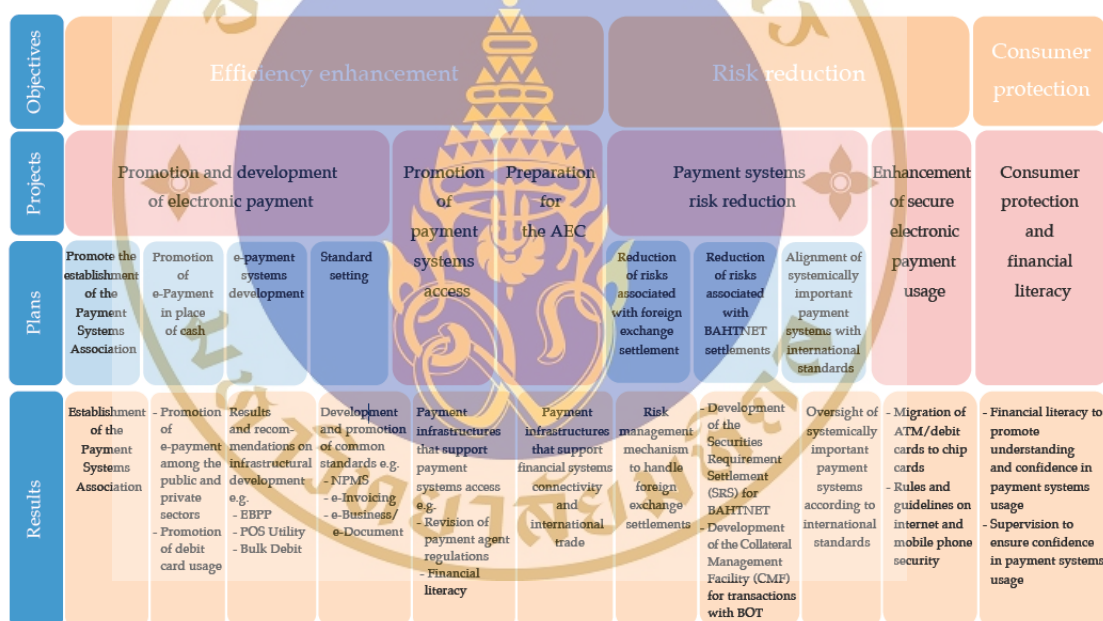


Figure 2.1 Thailand Payment Systems Roadmap 2012-2016

The objective of the Payment Systems Roadmap 2012 – 2016 objective to ensure Thailand’s payment systems has mechanism to facilitate efficient, stable and safe economic activities of the public and private sectors, both domestically and internationally. The Roadmap covers three main objectives which are Payment Systems efficiency enhancement, The promotion of payment access and

The preparation for the AEC. From the Payment Systems Roadmap convert to five projects under the National e-Payment Master Plan.

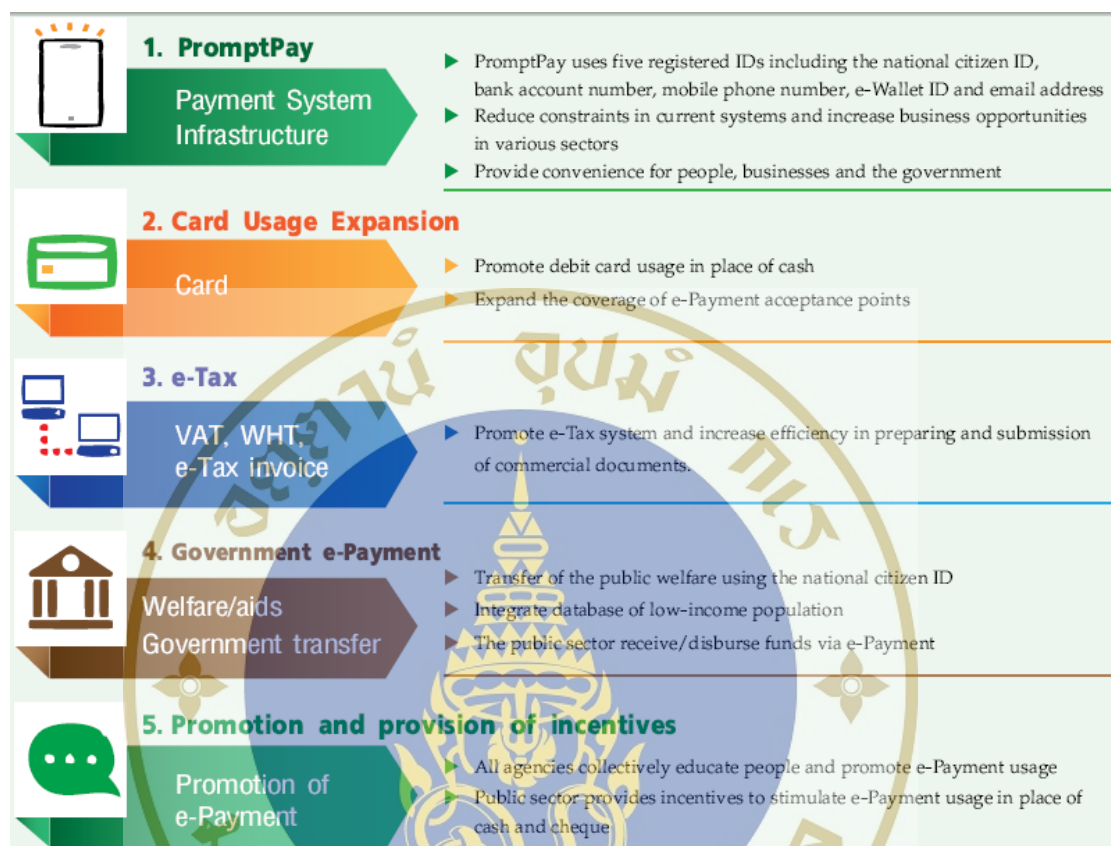


Figure 2.2 Five project under the National e-Payment Master Plan

On this research, author focus on Prompt Pay Payment System Infrastructure project which related to QR Code payment technology in project detail.

Prompt Pay, is a project approved by Thailand Cabinet under Thailand Payment System Roadmap to develop the fundamental infrastructure plan, which will introduce Thailand's economy by adopting new payment technology. Prompt Pay is a part of National e-Payment, a new money transfer and remittance service. This is an attempt to change the money transfer or current payment behavior from funds transfer or regular payment by not using multiple bank account numbers which makes it difficult for customer to remember and communicate as payment or transfer money in the system. This can be done by using another unique number that the transferee has registered with the financial institution. In the early stages, it starts with Citizen

Identity numbers (CID) and Mobile phone numbers. It makes it easier for customer to make payments between public and private sectors. While transfers between individuals or between consumers and the business sector are more convenient and secure. This will further expand to include an electronic payment card, resulting in lower cash management costs and also results in a lower transfer fee. At the same time consumers have more choice for money payment than today.

Currently Prompt Pay already roll out and service available in Thailand since early of January 2017, The Bank of Thailand (BOT) has released the latest update of Prompt Pay as of May 14, 2017 with 27.8 million Thai registered with Prompt Pay. Also to move on Prompt Pay infrastructure utilization, BOT also released the QR Code/2D Barcode Guideline which is a standard for QR code to allow e-Payment service providers, retailers and businesses to exchange information, with the same data format. This could enable all the stakeholder would like to the diffusion pattern of QR code payment technology then they can plan and gain benefit for new technology change.

2.2 QR Code Means

QR codes or the full name is quick response codes is a type of matrix barcode or two-dimensional barcode, First appearing in Japan in the mid-1990's, In the early stage to utilize QR code adopted by marketers across various industries to inform and provide product information by putting URL when generate QR code which customer can scan the code using their smartphones and get access to the website automatically. The QR code can apply in vary situation and benefit such as putting to the name card, poster , web site, book, news paper, plastic bottom, a cup of coffee etc.

Now the QR code has been applied to the payment process by customer can scan the QR code at merchant point of sale before paying stuffs or merchant can scan customer QR code in customer mobile for request to pay money before giving things to customer.

The QR codes are read by a mobile device through the device's camera using an application specifically designed to read the information embedded in the code. QR codes are easily recognizable by their square shape and series of black

square/white space patterns. The size of the QR code is largely irrelevant: as long as the device's camera can bring the code into the field of view, the code can be read by the code reader application (Julia *et al.*, 2014)



Figure 2.3 The Sample of QR code

2.3 Mobile Payment in upcountry

China the Chinese Central Bank officially approved QR payments for the first time after calling off such an approval in 2014 then the country fast adopting QR code payment as nation-wide payment method which motivating and promoting by the big giant e-commerce in China “Alibaba Group”. The Chinese people scan QR codes to pay for all the things that they can scan and pay from Online to Offline market.

According to Mobile payment report in China, 2016. The Chinese mobile payment market has grown rapidly and will reach ¥12.2 trillion (US\$1.83 trillion) in 2016, also the E-wallets account is the highest percentage globally for a 58% share of the mobile payment market which present that the mobile payments are an integral part of the Chinese shopping experience. In theUS, the figure is just 15% and in the UK,it is 23%.

The mobile payment systems in China based on NFC and QR code technologies which QR code payment is growing faster than NFC technology and more affordable by Chinese people to buy and use for mobile payment in their life.

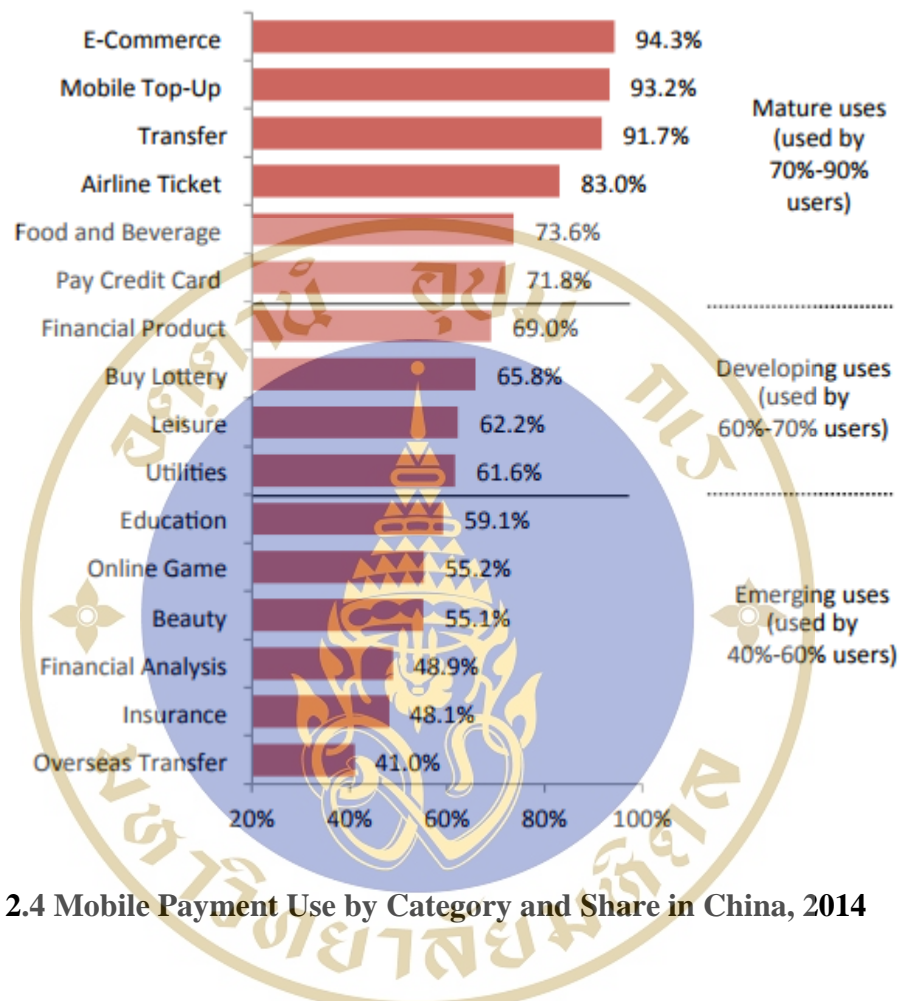


Figure 2.4 Mobile Payment Use by Category and Share in China, 2014

India, the India Government is the key driver for investment in developing new payment services such as digital wallets and QR code-based services. The India QR is a government-mandated initiative which has been developed by Card company including of MasterCard, Visa and RuPay by launching in Mumbai and is designed to make the QR codes present in as many merchants as possible which has the consequently in term of various payment and related services. Also the Paytm, an ecommerce company which mainly back up by Alibaba in China, has investing about \$900 million (6 billion rupees) in the development of a new QR-based payments service. The company also plans to train 10 million merchants to accept digital payments across 650 districts before the end of year 2017.

According to BCG-Google Digital Payments report 2016, Aadhaar making know your customer (KYC) easier in India. The Aadhaar card is a government-issued unique identity card that contains the individual's biometric and personal information. When customer apply for mobile payment then it's just linking a customer's mobile number in automated process to his/her Aadhaar account without the need for documentation, photographs etc, which make the wallet users have more than mobile banking users and triple the number of credit card users

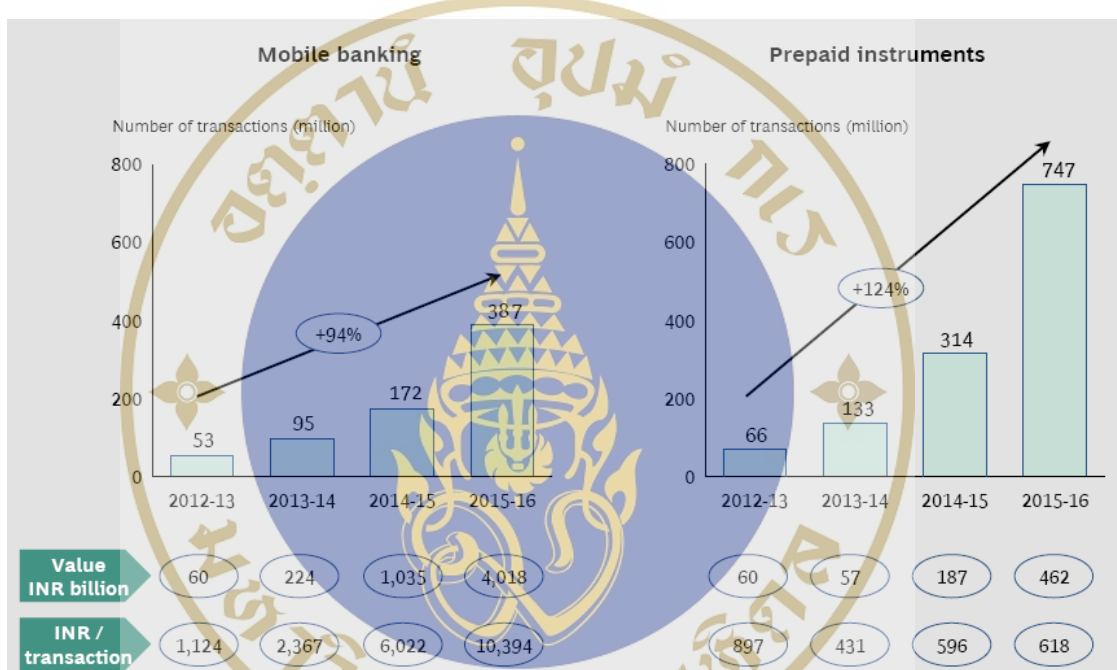


Figure 2.5 Prepaid Instruments Transaction almost 2X of Mobile Banking Transactions in India

2.4 Card and QR Code Payment

The card payment and QR Code payment have the similar steps when performing the payment at merchants

Table 2.1 Card and QR Code payment steps at merchant

Step	Card Payment	QR Code Payment
1	Customer applied and prepare the payment card e.g. debit/credit card	Customer applied mobile banking and prepare smart phone with QR scanning function
2	Merchant enter transaction amount at Point of Sale System (POS)	Merchant enter transaction amount at Point of Sale System (POS)
3	POS display payment amount and connect to EDC and wait for card payment	POS display payment amount in QR format and wait for payment
4	Merchant ask payment card from customer to swipe at EDC and enter the amount	Merchant ask customer to scan the QR and enter the amount
5	Merchant ask customer sign on the slip to approve and verify the card owner	Customer enter the secret PIN to approve and verify the account owner
6	Credit transfer from buyer to merchant, payment finish	Credit transfer from buyer to merchant, payment finish



Figure 2.6 Card and QR Code payment

2.5 Theoretical Framework

Diffusion of Innovation Theory, the difference among individual in their response to the new ideas in form of new product, technology is called their innovativeness which means the degree to which an individual is relatively early or late in adopting a new idea. There are four category of adopter technology (Rogers, 1995).

Innovators: Innovators are the first individuals to adopt an innovation.

Early adopters: This is the second fastest category of individuals who adopt an innovation.

Early majority: Individuals in this category adopt an innovation after a varying degree of time.

Late majority: Individuals in this category will adopt an innovation after the average member of the society does

Laggards: Individuals in this category are the last to adopt an innovation.

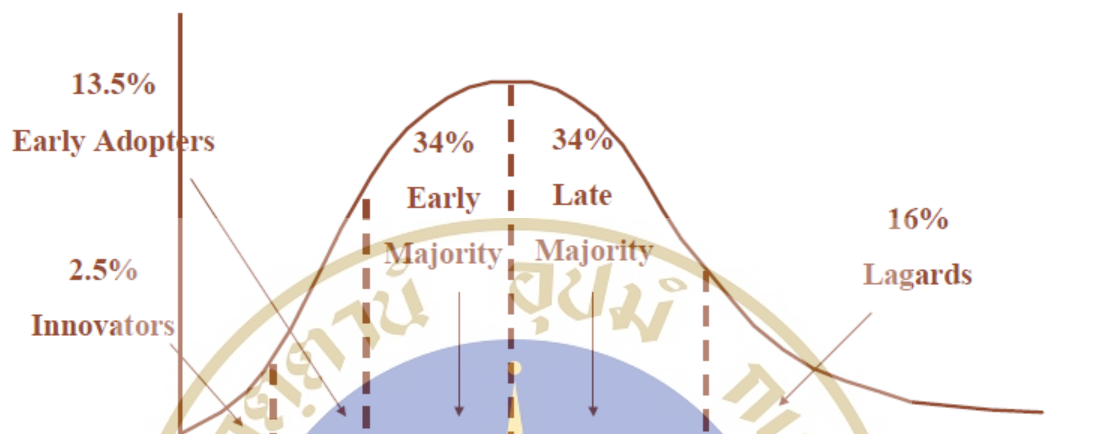


Figure 2.7 Diffusion of Innovation Model

Technology Acceptance Model, The Technology Acceptance Model (TAM) proposed that perceived usefulness and perceived ease of use are principles about a new technology that influence an individual's attitude toward and use of that technology (Davis, 1989). The QR code payment adoption can be related to many factors such as customer experience, personal believe, social influencing environment or level of technology knowledge.

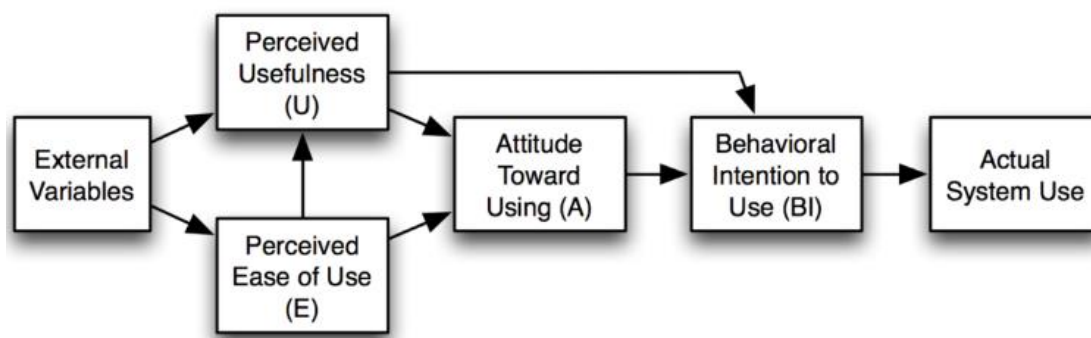


Figure 2.8 Technology Acceptance Model

BASS Diffusion Model, BASS model is the acceptable business model which use to forecast the diffusion pattern of new product, new technology before the company has to design the proper plan and investing more resource in them. BASS model aim to provide the information about how many customers will adopt the new product, new technology by when. The BASS model combine both external factors (mass communication) and internal factors to forecast the technology diffusion pattern. Bass model has been accepted and applied in wide industry from high correlation by comparing the forecast data with the actual result (Tansurat & Gerdri, 2016).

The Bass model offer a good starting point for forecasting the long-term sales pattern of new technologies and new durable products under two types of conditions.

The company has recently introduced the product or technology and has observed its sales for a few time periods; or

The company has not yet introduced the product or technology but it is similar in some way to existing products or technologies whose sales history is known.

BASS model consider 3 keys parameters which are m means the total number of potential customers (market) of the new technology such as the total number of mobile phone users, p is the Coefficient of innovation (or coefficient of external influence) of first technology adopter group which independent from other buyers, q is the Coefficient of imitation (or coefficient of internal influence) of later technology adopter group which dependent with other buyers.

$$n(t) = \left[p + \frac{q}{m} N(t-1) \right] [m - N(t-1)]$$

Figure 2.9 BASS Model formula and parameters

$n(t)$ is the total number of adopters of the new technology up to time t

$N(t-1)$ is the cumulative number of adopters the new technology since the early stage

p is the Coefficient of innovation (or coefficient of external influence)

q is the Coefficient of imitation (or coefficient of internal influence)

m is total number of potential customers of the new product/technology

In this thematic paper target to use BASS diffusion model based to forecast the diffusion pattern of QR payment technology in Thailand.



CHAPTER III

RESEARCH METHODOLOGY

By using BASS diffusion model to forecast the diffusion pattern of QR payment technology in Thailand, there is important to know about advantage, disadvantage and limitation of BASS model as following (Lertriluck & Gerdri, 2015).

BASS model is workable to forecast the new technology diffusion pattern without knowing the history data in case of new technology never use in the past which no history data.

The technology which is in the same category (Analogous Technology), will represent the similar value of Coefficient of Innovation p and the Coefficient of Imitation q .

The m (Market Potential) value require from the trusted source, as much as m value define more realistic then Bass model will provide the forecasting diffusion pattern almost to the actual pattern.

The history data use in Bass model need at least 3 period of cycle time.

Bass model could provide the result almost to the actual if the history data from analogous technology already pass through the peak period.

3.1 Research Design

The research deeply collecting qualified secondary data from the trusted source, in this case means the Bank of Thailand (BOT). BOT has published the usefulness data related to Thailand Electronic Payment Transaction in BOT website section Payment System Report which could be backward to 20 years ago starting from year 1996 – 2015.

In Payment System Report, the research focus on payment statistics related to number of credit cards, number of debit cards, number of ATM cards, the Use of Mobile Banking and Internet Banking. The research follow steps below

Step1 Performing the literature review for relevant research topic, article and report of QR code payment.

Step 2 Collecting history data to create Bass model including of the estimated number of smart phone in the future (m), identify the Coefficient of Innovation p , the Coefficient of Imitation q .

As of QR payment never use in Thailand so to identify p and q value require the representative p and q value from the analogous technology, in this research identify the card payment could be the analogous technology with QR code payment technology then the collecting history data start from card statistic data which published from BOT and identify which card payment type among ATM, Debit and Credit card has already pass through the peak period to be use as history data.

By using the BASS diffusion model in excel tool which publish in website forecastingsolutions.com could be used to identify the p and q value from history data of the analogous technology.

Step 3 Creating the QR code payment diffusion pattern in S-Curve following BASS model by using BASS creation excel tool from University of Washington website.

Step 4 Comparing the QR code payment diffusion pattern following BASS model with the actual data of the Use of Mobile Banking which public from

BOT to ensure the applicable to use p and q value from history data of the analogous technology means card payment data in this case.

Step 5 Conclusion and analysis the QR code payment diffusion pattern result and provide suggestion for future research.



CHAPTER IV DATA ANALYSIS

4.1 Card Payment Statistic

This research bases on the secondary data related to card payment statistic which represent in the Payment System Report from BOT website. The card payment statistic data available backward to 20 years starting from year 1996 – 2015.

Table 4.1 Card Payment Statistic (Number of Cards) during 1996 – 2015

Year	Credit	Debit	ATM	Total
1996	1,972,000	-	15,557,000	17,529,000
1997	2,010,000	-	17,923,000	19,933,000
1998	1,906,645	-	15,698,000	17,604,645
1999	1,629,301	-	17,465,704	19,095,005
2000	1,765,640	-	20,681,782	22,447,422
2001	2,567,961	-	23,782,842	26,350,803
2002	3,419,988	-	26,802,158	30,222,146
2003	4,224,362	-	29,666,295	33,890,657
2004	8,648,100	-	25,653,079	34,301,179
2005	9,958,571	11,043,800	28,752,512	49,754,883
2006	10,900,566	3,952,784	30,845,358	45,698,708
2007	12,003,369	23,293,608	22,632,173	57,929,150

Table 4.1 Card Payment Statistic (Number of Cards) during 1996 – 2015 (cont.)

Year	Credit	Debit	ATM	Total
2008	12,971,694	26,266,359	22,423,525	61,661,578
2009	13,489,422	30,703,339	21,039,987	65,232,748
2010	14,196,173	34,130,520	20,991,627	69,318,320
2011	15,328,291	38,733,246	23,756,810	77,818,347
2012	16,870,025	42,988,140	24,108,467	83,966,632
2013	18,626,864	45,241,477	24,101,957	87,970,298
2014	20,303,751	48,121,065	24,401,333	92,826,149
2015	21,762,471	50,413,672	21,743,686	93,919,829

**Figure 4.1 Card Payment Statistic (Number of Cards) during 1996 – 2015**

From the Card payment statistic data present the ATM card start on year 1996 and has the peak period during year 2003 – 2007 then step down until year 2015.

According to BASS model observation, Bass model could provide the result almost to the actual if the history data from analogous technology already pass through the peak period then the number of card payment including ATM cards history data has been selected to be used as the analogous technology history data to identify the p and q value to estimate QR code payment pattern following BASS model.

4.2 Identify BASS Model Parameters

By using BASS model excel tool from website forecastingsolutions.com with the number of ATM cards history data during the year 1996 – 2015 could identified the value of $p = 0.00163$ and $q = 0.691$.

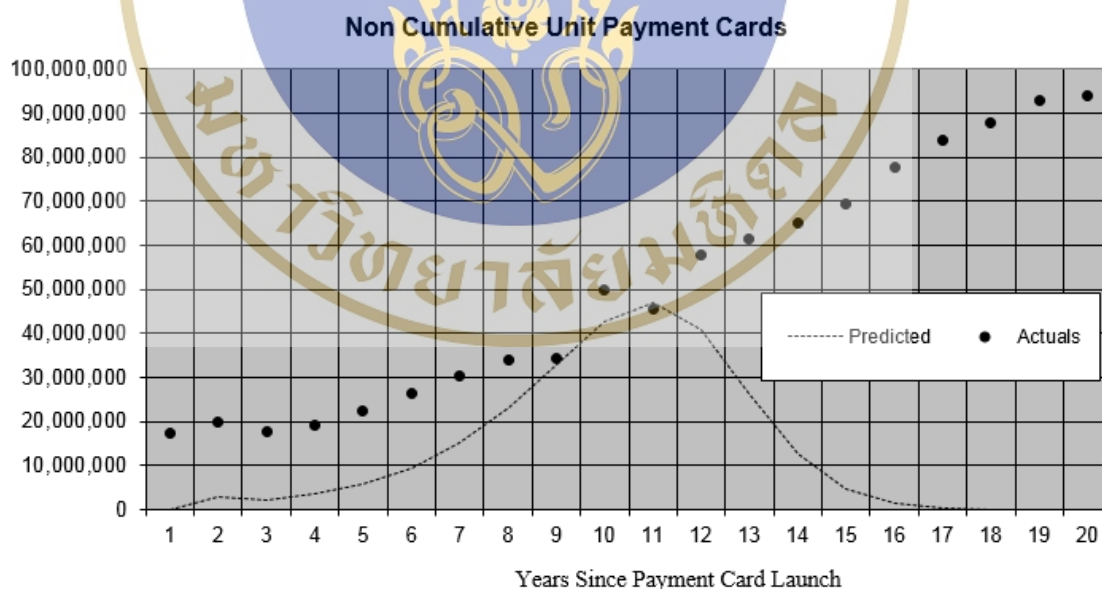


Figure 4.2 The Unscrambling Regression Coefficients for p and q from Payment Card data during year 1996 – 2015

According to Ericson mobility report 2016, the number of smart mobile device will be double digit increasing from 40 million devices in year 2013 to 80 million devices within year 2021, then the m value which is total number of potential customers of the new technology could identify at 80 million devices.

4.3 BASS Diffusion Model Generation

The BASS diffusion model could generate by using the BASS model excel tool from University of Washington website to generate BASS diffusion pattern for QR code payment in Thailand by inputting BASS model parameters value of $p = 0.00163$, $q = 0.691$ and $m = 80,000,000$

$$n(t) = \left[p + \frac{q}{m} N(t-1) \right] [m - N(t-1)]$$

Figure 4.3 BASS Model formula and parameters

$n(t)$ is the total number of adopters of the new technology up to time t

$N(t-1)$ is the cumulative number of adopters the new technology since the early stage

p is the Coefficient of innovation (or coefficient of external influence), $p = 0.00163$

q is the Coefficient of imitation (or coefficient of internal influence), $q = 0.691$

m is the number of potential customers of the new product/technology, $m = 80,000,000$

Table 4.2 BASS Diffusion Model Data for QR Code Payment in Thailand

Year	Users	Cum. Users
2009	0	0
2010	130,400	130,400
2011	220,147	350,547
2012	370,995	721,542
2013	623,313	1,344,855
2014	1,041,880	2,386,735
2015	1,726,540	4,113,275
2016	2,819,830	6,933,106
2017	4,494,688	11,427,794
2022	6,880,369	18,308,162
2023	9,856,305	28,164,467
2024	12,694,552	40,859,019
2025	13,877,426	54,736,445
2026	11,985,436	66,721,881
2027	7,673,959	74,395,840
2028	3,610,335	78,006,175
2029	1,346,646	79,352,821
2030	444,638	79,797,459
2033	139,932	79,937,391
2034	43,331	79,980,722
2035	13,349	79,994,071

Table 4.2 BASS Diffusion Model Data for QR Code Payment in Thailand (cont.)

Year	Users	Cum. Users
2036	4,106	79,998,177
2037	1,262	79,999,440
2038	388	79,999,828
2039	119	79,999,947
2040	37	79,999,984
2041	11	79,999,995
2042	3	79,999,998
2043	1	80,000,000
2044	0	80,000,000

4.4 BASS Diffusion Model Parameters Validation

The BASS model parameters value of $p = 0.00155$, $q = 0.9982$ could be validated by comparing with the actual data of the Use of Mobile Banking with QR code scanning function during year 2014 – 2016 which public from BOT and using the mean absolute percentage error (MAPE) method to measure the accuracy of prediction number. The result show the average MAPE is 66.31%.

Table 4.3 the Use of Mobile Banking with QR code scanning function

Year	Actual Number of Mobile Banking Users	Forecasting Number of QR Code Payment Users	MAPE (%)
2014	6,229,960	2,386,735	61.69
2015	13,918,815	4,113,275	70.45
2016	20,883,147	6,933,106	66.80
		Average MAPE	66.31

4.5 BASS Diffusion Model Parameters Adjustment

The BASS model with parameters value of $p = 0.00163$, $q = 0.691$ and $m = 80,000,000$ show the MAPE result is 66.31% which quite high and unacceptable then the adjustment with trial and error of BASS model parameters value to find out the possible of p and q value with acceptable MAPE is required. The result show with new $p = 0.00155$, $q = 0.9982$ and $m = 80,000,000$ show the MAPE result is 39.26%.

Table 4.4 The forecasting Number of QR code Payment after parameter adjustment to improve MAPE rate

Year	Actual Number of Mobile Banking Users	Forecasting Number of QR Code Payment Users	MAPE (%)
2014	6,229,960	3,754,492	39.73
2015	13,918,815	7,444,522	46.51
2016	20,883,147	14,296,590	31.54
Average MAPE			39.26

Table 4.5 BASS Diffusion Model Data after parameter adjustment

Year	Users	Cum. Users
2009	0	0
2010	124,000	124,000
2011	247,393	371,393
2012	492,428	863,820
2013	975,616	1,839,436
2014	1,915,056	3,754,492
2015	3,690,029	7,444,522
2016	6,852,068	14,296,590
2017	11,822,389	26,118,979
2018	17,643,317	43,762,296
2019	19,843,551	63,605,847
2020	13,036,499	76,642,346
2021	3,216,146	79,858,491
2022	141,224	79,999,715
2023	285	80,000,000
2024	0	80,000,000

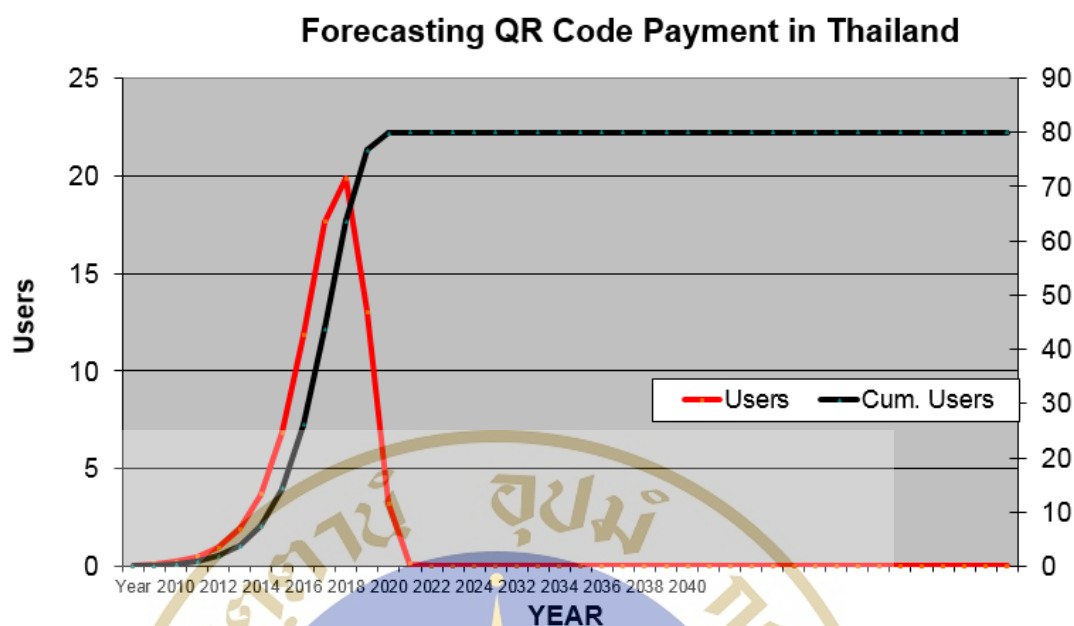


Figure 4.4 BASS Diffusion Model for QR Code Payment Compare with the Actual data of Mobile Banking with QR code scanning during 2014 - 2016

4.6 QR Code Payment Diffusion Parameters Validation

The QR Code payment diffusion created from BASS model with parameters value of $p = 0.00155$, $q = 0.9982$ and $m=80,000,000$ could be validated by comparing with the actual data of the Use of Mobile Banking with QR code scanning function over 3 years from year 2014 – 2016 which public from BOT.

Table 4.6 the actual use of Mobile Banking with QR code scanning

Year	Actual Number of Mobile Banking Users	Forecasting Number of QR Code Payment Users
2014	6,229,960	2,386,735
2015	13,918,815	4,113,275
2016	20,883,147	6,933,106

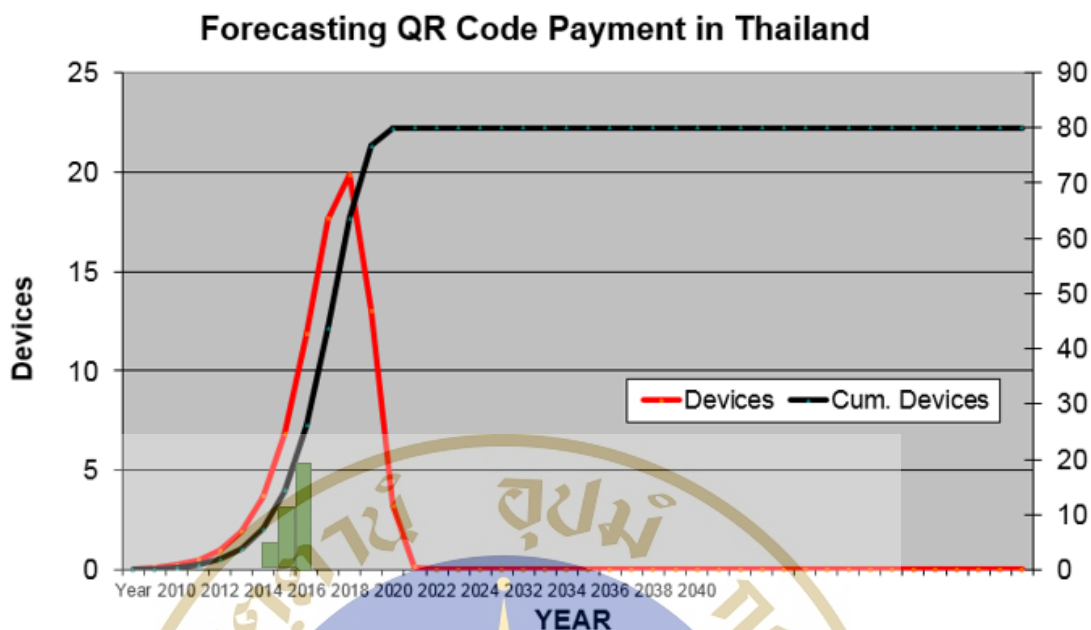


Figure 4.5 QR Code Payment Diffusion Pattern Compare with the Actual data of Mobile Banking Users with QR Scanning Function during 2014 - 2016

4.5 Findings

According to the card payment technology selected as the analogous technology to identify BASS model parameters value of $p = 0.00155$, $q = 0.9982$ and setting $m = 80,000,000$. The result shown QR code payment diffusion pattern has highest adoption between year 2018 – 2020 with the approximately of adoption mobile device between 60 – 70 million devices.

The result has been validated against the actual number of mobile banking users with QR code scanning function during year 2014-2016 found the MAPE = 39% which means the forecasting of QR payment diffusion pattern has the accuracy level at 61%, hence the value of $p = 0.00155$, $q = 0.9982$ and $m = 80,000,000$ is acceptable.

CHAPTER V

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The result of QR code payment diffusion pattern present the QR code payment has highest adoption during the year 2018 – 2020 with the number of adoption mobile devices between 60 – 70 million devices could benefit to the business organization to prioritize and plan the resource e.g. expertise person, financial in term of investment budget and time line for implementation to gain benefit from QR code payment occurring in Thailand.

5.2 Recommendations

To gain benefit as a result of the diffusion pattern of QR Code payment, the business organization has to prioritize and plan to cover both merchant and consumer areas as following items.

5.2.1 Target Merchants and Consumers

It is necessary to understand both merchant and consumer behavior to identify target group for QR code payment adoption. The priority merchant could be the merchant in business to customer (B2C) model which business or transactions conducted directly as face to face between a merchant and consumers to get products or use services. The sample of B2C is retailer or service provider in food restaurant, fashion, drug store, fresh market etc. while the priority consumer group could be the teen and office working group who easily adopt to the mobile technology payment.

5.2.2 Marketing Promotion and Customer Education

It is important to emphasize that the successful of QR payment adoption on mobile is the use of marketing tools to create the motivation strategic campaigns with the plan to educate customers on the convenience of new form of payment.

The campaign should also focus on demonstrating how the new payment method is made consumers life easier. It should also make clear that the QR payment on mobile is safe by getting notification alert with sufficiency enough information to both seller and buyer in real-time then they can verify and cross check the correctness of money transfer from and in to the wallet or account. Also to motivate the consumer continual usage, the promotion like discounts and cash back could encourage customer open to using the QR code payment on mobile. The linkage between online and off line at the point of sale such as retail shop, food and entertainment have valuable to connect and design the customer experience.

5.2.3 Convenience, Trust and Security Maintain

The simple UX/UI design which use to design application screen and flow when merchant and consumer performing the QR code payment is quite important for expanding customer adoption rate so to maintain the simple and easy concept along the customer journey flow are mandatory to apply. The difficulty and complexity of enrollment process is the key barrier during customer acquisition process. Also the performance and security maintenance that need to ensure the less time processing and security protection during the payment process comparing with cash payment is the other key factors to maintain consumer trust and perception when use QR code payment. The QR code generating from any channels or device either by merchant or consumer side should compliance with global QR code specification in this case means EMV QRPCS. According to QR Code Specification for Payment Systems (EMV QRCPS), 2017 present this standard accepted by 5 key card brands including of Visa, MasterCard, American Express, China Union Pay and JCB,Discover/Diners

Club International. By compliance with global QR specification enabling the merchant can accept source of fund from vary credit card brand.

5.3 Limitations

The limited of following items cause this study the shrink in the result.

5.3.1 Data available only consumer's side

With the available date e.g. from BOT including the number of card payment records, number of mobile banking contracts or the forecasting number of smart phone devices in Thailand from Ericson mobility report, 2016 represent only data from consumers side while no data available from merchant side e.g. number of merchants that register and accept the QR code payment. Only one side data use may impact to the result of QR code payment diffusion pattern in term of adoption time due to the QR code payment process require interaction from both merchant and consumer side.

5.3.2 Data used only from banking industry

The key data used in the study mainly from BOT which collecting data from banking industries in Thailand. For more accurate and high acceptable level in the technology diffusion pattern, the more source of data from non-financial organization is required. The sample of non-financial e.g. from telco areas which own the e-wallet and mobile application with QR code scanning function that could apply to the QR code payment process. The useful additional data from non-financial sectors e.g. the number of e-money contract which could add to the number of mobile banking contracts for bigger scales of readiness group to perform QR code scanning activity. The well-known of trusted source of data are needed to be reviewed in order to gain more credibility and reliability of the outcomes.

5.3.3 The number of QR code scanning devices

The study used a forecasting number of smart phone devices in Thailand from Ericson mobility report 2016 due to almost of smart phone has the embedded camera which could use to scan the QR code. In fact not only the smart phone can scan the QR code but non-smart phone with digital camera could scan the QR code e.g. smart watch, smart glasses. By adding the non-smart phone with digital camera could increase the accuracy of QR code payment diffusion pattern.

5.4 Future Research

The suggestion for future research shown as following items.

5.4.1 Expanding research to cover the adoption factors of QR code payment

This study not in deep detail to analyze the adoption factors of QR code payment. The further research could perform to figure out the key motivators or barriers for adoption of QR code payment e.g. the habit to use cash, difficulty of applying process, complexity of using, security and fraud concerned, promotion and motivation factors etc. The research result could benefit for business organization to have proper plan and investment to increase QR code payment adoption rate.

5.4.2 Changing to the other analogous technology

This study use card payment technology as the analogous technology with QR code payment to identify the BASS model parameters to forecast QR code diffusion pattern in Thailand. The other analogous technology such as cardless payment e.g. Sumsung Pay technology, NFC payment etc, could consider as the analogous technology with QR code payment for future research.

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APENDIX A

BASS Model Parameters

The Unscrambling Regression Coefficients use to find out p and q value by using Card Payment history data following BASS model parameter requirement.

$N_{bar} = 271,128,740$, $p = 0.00163$, $q = 0.691$

Year	Actual Non-Cumulative	Actual Cumulative
	<u>Actuals</u>	<u>Actuals</u>
1996	17,529,000	17,529,000
1997	19,933,000	37,462,000
1998	17,604,645	55,066,645
1999	19,095,005	74,161,650
2000	22,447,422	96,609,072
2001	26,350,803	122,959,875
2002	30,222,146	153,182,021
2003	33,890,657	187,072,678
2004	34,301,179	221,373,857
2005	49,754,883	271,128,740
2006	45,698,708	316,827,448
2007	57,929,150	374,756,598
2008	61,661,578	436,418,176
2009	65,232,748	501,650,924
2010	69,318,320	570,969,244
Year	Actual Non-Cumulative	Actual Cumulative
2011	77,818,347	648,787,591
2012	83,966,632	732,754,223

2013	87,970,298	820,724,521
2014	92,826,149	913,550,670
2015	93,919,829	1,007,470,499

Regression Statistics	
Multiple R	0.949371199
R Square	0.901305673
Adjusted R Square	0.873107294
Standard Error	262.9767883
Observations	20

ANOVA

	df	SS	MS	F	Significance F
Regression	2	4420921	2210460.681	31.96303129	0.000302011
Residual	7	484097.5	69156.79119		
Total	9	4905019			

