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ACCEPTANCE OF QR CODE IN TAIWAN: AN EXTENSION OF THE TECHNOLOGY ACCEPTANCE MODEL

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Abstract

The development and application of QR code is quite advanced in Japan and Korea; in contrast, at the time when the QR code was introduced in Taiwan, lack of mobile phone support and the limited applications of QR code meant that it was not immediately popularized. In recent years, the growing popularity of smart phones has enhanced the various applications of QR code, not only providing the information to the user, but also performing navigation, marketing and ticketing functions, to name a few. This study is based on the Technology Acceptance Model, with Social Influence, Facilitating Conditions, Awareness Knowledge, Operation Knowledge and Price as the usage factors, and by verifying the structural modelling through public surveys and analyzing the importance of the Acceptance Model and other influences of users in Taiwan as the driving factors in incorporating QR code applications in the government, telecommunication carrier and business spheres.

Keywords: QR Code, Mobile Application, Technology Acceptance Model.

1 INTRODUCTION

QR code has evolved from the traditional bar code, but contains more information. Originally, QR Code was invented by a Japanese company, Denso-Wave, in 1994 for the use of tracking parts consumed in automobile manufacture. Code information can be read by taking a picture of QR code using a mobile phone, and users can access the internet via QR code reading a Web address and get richer content by browsing through it, which encourages a brand new mobile business model.

Although QR code was launched in Taiwan in 2005, the level of utilization and popularity was far from that in Japan until now. The situation in Europe and the U.S. was similar, particularly as mobile phone manufacturers and carriers did not strongly promote the use of QR code, and mobile phone decoding was not supported and therefore unpopular. However, at the end of 2009, Google incorporated QR code in its Favorite Place feature, picking the top 100,000 popular stores which its users visited the most on the internet, and providing the stores with QR code stickers and having them posted on the door. In addition, Google added the API encoding which supports QR Code on its function list of Chart API. With the recent booming usage of smart phones such as the iPhone and Google Android, the applications developed for mobile phones have become more diverse, and the instances of using QR code in the U.S. and Europe have increased.

As the general public lacked interest or knowledge of QR code due to it not being broadly promoted, the initial investment from the industry and government was not particularly profitable. Therefore, this study is based on the Technology Acceptance Model (TAM) which Venkatesh and Davis proposed in 2000 (Venkatesh & Davis 2000), adding the impact of intention to use QR code and related factors as considerations, by conducting public surveys exploring the general public's willingness to use QR code and identifying the key factors relating to usage in order to resolve the doubts between government, telecommunication carriers and the general public. This study aims to assist the government and related industries in smoothly implementing and popularizing the application of QR code, and encouraging the general public to use QR code in Taiwan.

2 LITERATURE REVIEW

2.1 Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) was proposed by Davis et al. (1989), based on the Theory of Reasoned Action (TRA) and modified especially for measuring the information system of user acceptance. The purpose of TAM is to simplify TRA and retain its relationship of belief - attitude - intention - behavior, abandon the influence of subjective norm and provide a theoretical based model to explain or predict various factors of user acceptance toward information technology.

The Technology Acceptance Model contains two major behavioral cognitive beliefs; "Perceived Usefulness" and "Perceived Ease of Use". According to Davis et al. (1989), Perceived Usefulness is the degree to which a person believes that using a particular system would enhance his or her job performance. Perceived Ease of Use is the degree to which a person believes that using a particular system would be free from effort. In Figure 1, TAM advocates that "Actual System Use" is influenced by the "Behavioral Intention to Use", and "Behavioral Intention to Use" is affected by "Attitude Toward Using" and "Perceived Usefulness". "Perceived Ease of Use" and "Perceived Usefulness" will influence the "Attitude Toward Using", then affect a user's behavior, and "Perceived Ease of Use" will also affect a user's "Perceived Usefulness" in respect of the technology.

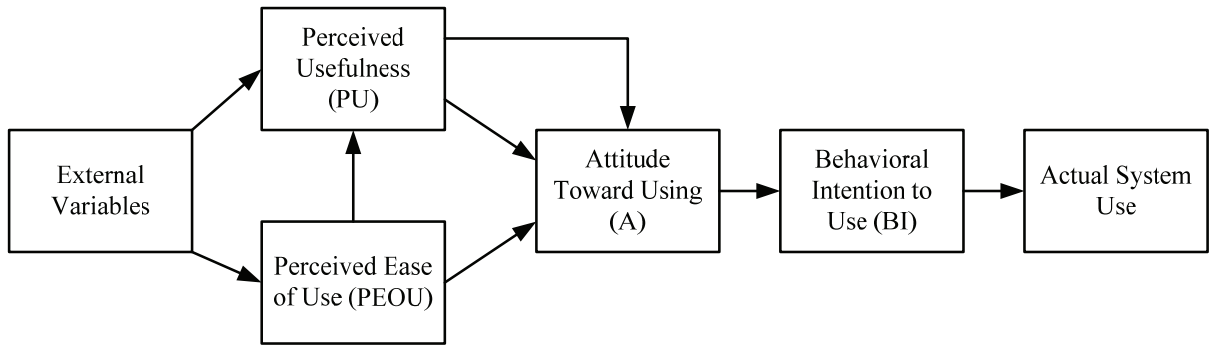


Figure 1. Technology Acceptance Model (Davis, 1989)

The "External Variables" referred to in the TAM includes a user's internal belief, attitude and intention connected to an individual's difference, situation, and controllable behavior, which is an underlying factor that indirectly influences a user's behavior. For example, different system characteristics will affect the user's Perceived Usefulness of that particular technology, while the characteristics of system design, training, and system operating manuals will affect the user's Perceived Ease of Use. Davis et al. (1989) found that "Attitude Toward Using" only played a small part of intermediate effect in the process of influence to "Intention to Use"; subsequently some scholars removed "Attitude Toward Using" from TAM, which has also obtained research support.

Furthermore, Venkatesh & Davis believe that a better understanding of the relationship between "Perceived Usefulness", "Perceived Ease of Use" and "Intention to Use" could be achieved by omitting the "Attitude Toward Using" from the TAM. Based on that, Davis & Venkatesh proposed a new Technology Acceptance Model 2 (2000) as shown in Figure 2, which identifies some "External Variables" which influence a user's "Perceived Usefulness" as "Subjective Norm", "Image", "Job Relevance", "Output Quality" and "Result Demonstrability", and the variables influence a user's "Intention to Use" as "Experience", "Voluntariness" and "Subjective Norm".

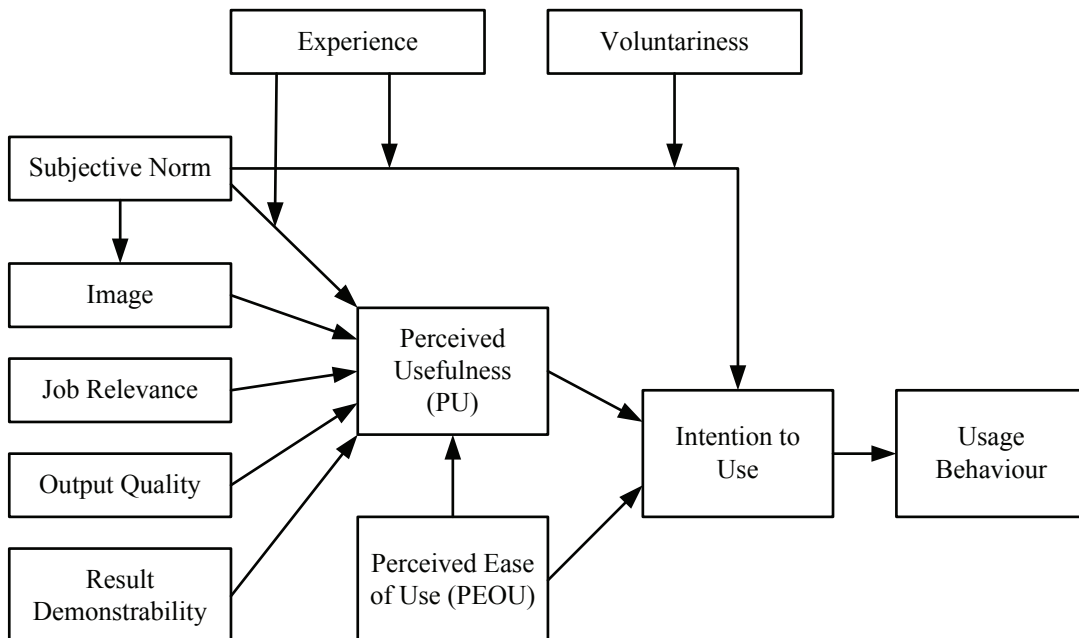


Figure 2. Technology Acceptance Model 2 (Venkatesh & Davis, 2000)

2.2 External Variables

2.2.1 *Social Influence*

The TAM2 proposed by Venkatesh & Davis lists the "Subjective Norm" as an influencing factor which directly impacts "Intention to Use", which might be weakening due to the passage of time and increasing experiences. After implementation of a system, both the strengths and weaknesses of the system would be revealed through experiences with the system, and the influence of "Subjective Norm" would be lessened accordingly. Therefore, under a condition of mandatory use, the direct impact of "Subjective Norm" to the "Intention to Use" is stronger at the system pre-implementation and early use phases; but the influence of "Subjective Norm" will be weakened through the increased instances of experience, and such experience does affect the "Perceived Usefulness" significantly.

Venkatesh et al. proposed the Unified Theory of Acceptance & Use of Technology (UTAUT) in 2003, which integrated the "Theory of Reasoned Action", "Theory of Planned Behavior", "Technology Acceptance Model" and "Diffusion of Innovation Theory", and offers four structural concepts which influence the behavioral intentions of a user. One of the concepts, "Social Influence", is that the 'individual's feeling is affected by the surrounding people', and with that, it includes "Subjective Norm" (1975), "Peer Influence" and "External Influence" (2000). "Subjective Norm" is defined as an individual's perception of whether people important to the individual think the behavior should be performed; "Peer Influence" is through friends, supervisors, classmates and others' point of view on the innovative behavior; "External Influence" is the information gathered from media reports, expert opinions and other information obtained from non-interpersonal relations.

Khalifa & Cheng (2002) studied the acceptance of Mobile commerce, while Hung et al. (2003) explored the impact factors for acceptance of WAP services, and both found the "Subjective Norm" has a positive influence on "Intention to Use".

2.2.2 *Facilitating Conditions*

Previous related research in Taiwan identified that the obstacles to promoting QR code resulted from the fact that decoding software (decoder) and high quality close-up photographs taken by mobile phone cameras were not commonly supported. In recent years, the uptake of smart phones, led by the iPhone, has meant that these phones are now capable of supporting QR code readers, and the software is freely available; applications can be easily downloaded directly from internet, and even Nokia pre-installed a QR code reader in its newly-marketed phones. All these developments have not only changed the user's mobile phone habits, but have also modified the key factors contributing to the promotion of QR code.

The UTAUT proposed by Venkatesh et al. (2003) indicates that "Facilitating Conditions" are where the consumer subjectively believes the support for currently available technology and equipment for software and hardware will affect the 'Intention to Use' the technical products, although this is subject to the relevant follow-up study to explore the UTAUT model, however, Louho et al. (2006) conducted a study using the UTAUT model in Finland to analyze the acceptance of mobile barcode scanning applications and found that "Facilitating Conditions" did affect the actual usage.

2.2.3 *Knowledge*

QR code emerged gradually in Taiwan but was not popularized as well as in Japan, as government and industry did not explicitly provide the general public with the relevant knowledge about the possible applications and usage of the code, so the realization of Taiwanese people as to both the existence and operation of QR code and related knowledge is also worthy of exploring.

Rogers (2003) believes that where a product or form of technology is brand new to the user and has not been encountered in the past, there is no reason for a user to like it. In the process of decision-making, the first phase is the 'cognitive phase' which is knowledge of the existence of the innovation and understanding its features, then the 'persuasion phase' which is the development of an attitude of like or dislike toward the innovation, and later followed by the 'decision phase' of acceptance or rejection of the innovation. A user must have related knowledge of the innovative product or technology, in order for it to be possible for the user to like and accept such product or technology, thus, an individual's awareness of the product is definitely a variable for discussion in relation to a product's acceptance and expansion.

In the course of conducting face to face interviews with members of the general public during Pagani's (2004) study of the acceptance of 3G multimedia application services, it was identified that interviewees believe that "knowledge" is an important variable which impacts "Perceived Usefulness" and "Perceived Ease of Use", and thus forming positive or negative attitudes towards new products or services. He also found that individuals' interest for 3G mobile multimedia services has a direct correlation to the level of service knowledge of the individuals - the less they know, the less they recognize the characteristics and the potential benefits of the service, which also leads to less interest for the particular service.

2.2.4 Perceived Price

Data for 2009 from the Market Intelligence & Consulting Institute (MIC) of Institute for Information Industry (III) indicate that "cheap cost" is the predominant factor in considering a mobile internet service, with its level of importance reaching 8.48 (out of 9) . The majority of applications for QR code require the use of mobile internet services, so the price charge of mobile internet service has to be a factor of consideration when discussing the Technology Acceptance Model in the context of QR code.

In the analysis of the acceptance of mobile banking by Luarn and Lin (2005), the cost of mobile devices and mobile services are the key factors that influence the "Intention to Use". Cheong & Park (2005) studied the acceptance of mobile networks and services in South Korea and Yu (2009) studied the acceptance of SMS-based mobile banking; both studies took into account Perceived Price Level (PPL) as a variable for their models. Perceived Price Level is the cost/effect measurement extended to an evaluation before actual use of the service by the consumer. The study results confirmed that Perceived Price Level not only affects the individual's attitude towards using a mobile internet service, but also influences the "Intention to Use".

3 RESEARCH MODEL AND HYPOTHESES

This study research model is based on the Technology Acceptance Model formulated by Venkatesh and Davis (2000) and Davis et al. (1998); it directly considers "Intention to Use", but not the "Attitude Toward Using" as the variables in the model. Hu et al. (1999) integrated previous study that "Intention to Use" can be used as a predictor of future use. Since QR code use is not widespread in Taiwan, it can be considered a brand new technology to the majority of the general public; in this situation the users lack actual experience, and accordingly the Technology Acceptance Model has been modified in this study to directly consider "Intention to Use" as a variable but not "Attitude Toward Using".

According to Venkatesh and Davis (2000) and Davis et al. (1998) study results, "Perceived Ease of Use" will affect the "Perceived Usefulness" positively, and "Intention to Use" would be positively influenced by "Perceived Usefulness" and "Perceived Ease of Use". Thus, hypotheses are proposed as follows: H1: Perceived Usefulness will influence Intention to Use. H2: Perceived Ease of Use will influence Intention to Use. H3: Perceived Ease of Use will influence Perceived Usefulness.

Based on the data provided by the Market Intelligence and Consulting Institute (MIC) of Institute for Information Industry (III) for 2009, the most important consideration for the general public in Taiwan in respect of mobile internet usage is "cheap cost". Luarn and Lin (2005) also believe that price is an important inhibitory factor for a user's "Intention to Use". Thus, a hypothesis is proposed as follows: H4: Perceived Price will influence Intention to Use.

The TAM2 model listed "Subjective Norm" as an influencing factor, subsequently UTAUT proposed by Venkatesh et al. (2003) modified it to "Social Influence", combined with the "Subjective Norm", "Peer Influence" and "External Influence" concepts as Bhattacharjee (2000) indicated, such that "Intention to Use" will be affected by "Social Influence". Therefore, hypotheses are proposed as follows: H5: Social Influence will influence Intention to Use. H6: Social Influence will influence Perceived Usefulness.

Pagani (2004) and other scholars believe "Intention to Use" would be influenced by a user's knowledge and preference of the product. When a user is adequately able to identify and characterize the advantages of a new product (Awareness Knowledge), positive evaluations by the user will follow; when a user is familiar with the new product (Operation Knowledge), then it is easier for the user to use/operate it. Therefore, hypotheses are proposed as follows: H7 : Awareness Knowledge will influence Perceived Usefulness. H8 : Operation Knowledge will influence Perceived Ease of Use.

The UTAUT proposed by Venkatesh et al. (2003) indicates that "Facilitating Conditions" occur where the consumer subjectively believes the support for currently available technology and equipment for required software and hardware will affect the 'Intention to Use' the technical products. Louho et al. (2006) also confirmed through research that "Facilitating Conditions" will affect the 'Intention to use'. Additionally, this study proposes that if the user obtains proper supporting software and hardware for QR code, it will also affect the user's awareness of usefulness and ease of use. Therefore, hypotheses are proposed as follows: H9 : Facilitating Conditions will influence Intention to Use. H10 : Facilitating Conditions will influence Perceived Usefulness. H11 : Facilitating Conditions will influence Perceived Ease of Use. Research model and hypotheses are shown in Figure 3.

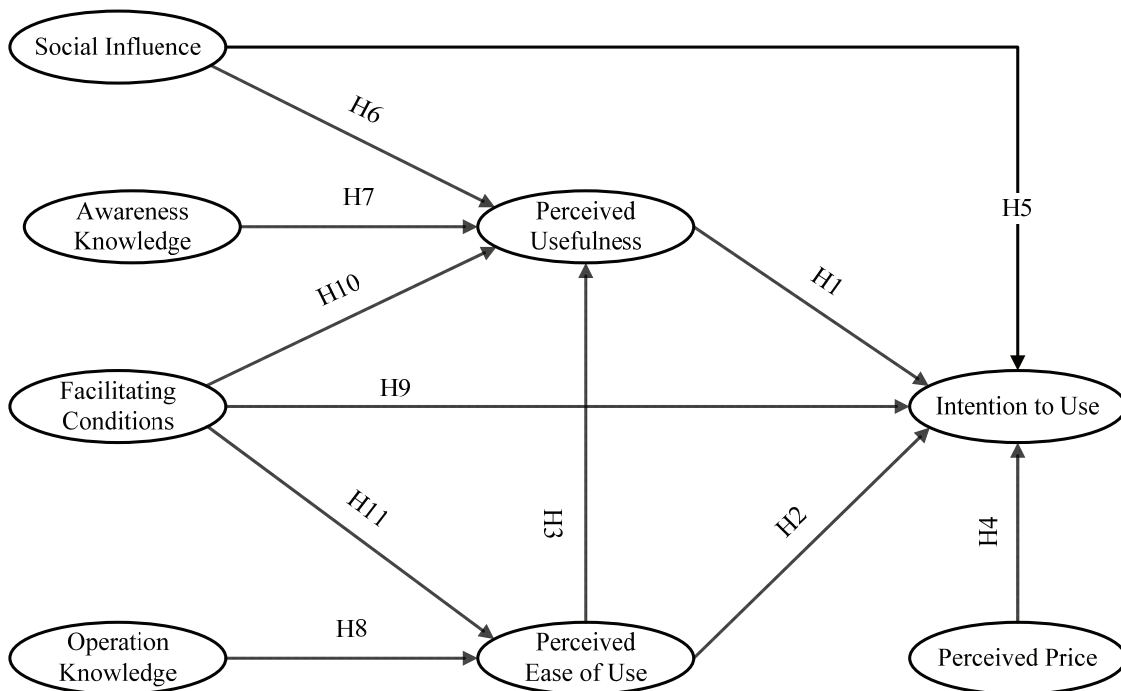


Figure.3 Research model and hypotheses

4 RESEARCH METHODOLOGY

4.1 Study Context and Sample.

The survey for this study covered the major cellular phone affiliated websites in Taiwan (Mobile01.com, Sogi.com), mobile phone related fan pages on Facebook, BBS electronic forum (bbs://ptt.cc mobile communication discussion site). Electronic questionnaires sent out via email had the advantage of wide-coverage and efficiency. Paper questionnaires were also dispatched to specific groups such like elderly and non-computer and non-internet populations, with the benefit of easy tracking.

4.2 Questionnaire Design.

A seven-point Likert-type scale questionnaire (with 1 being 'strongly disagree' and 7 being 'strongly agree') posing 46 questions was adopted for this study; results and data were integrated by statistical software and related analysis. Basic information was collected from the respondents such as gender, age, occupation, education level, residential location, averaged monthly income and cellular phone bill, current use (or lack thereof) of QR code applications, factors influencing willingness to use QR code application services, and types of QR code application for future consideration. SPSS 18.0 and AMOS analysis software was used in the study for descriptive statistics, reliability and validity analysis, as well as the Structural Equation Models (SEM) analysis.

5 DATA ANALYSIS

5.1 Descriptive Statistics

Both electronic and paper questionnaires were sent out or dispatched for survey, of these, 305 questionnaires were returned, and total of 287 valid questionnaires were received. Total valid samples accounted for 94.1% of returned samples.

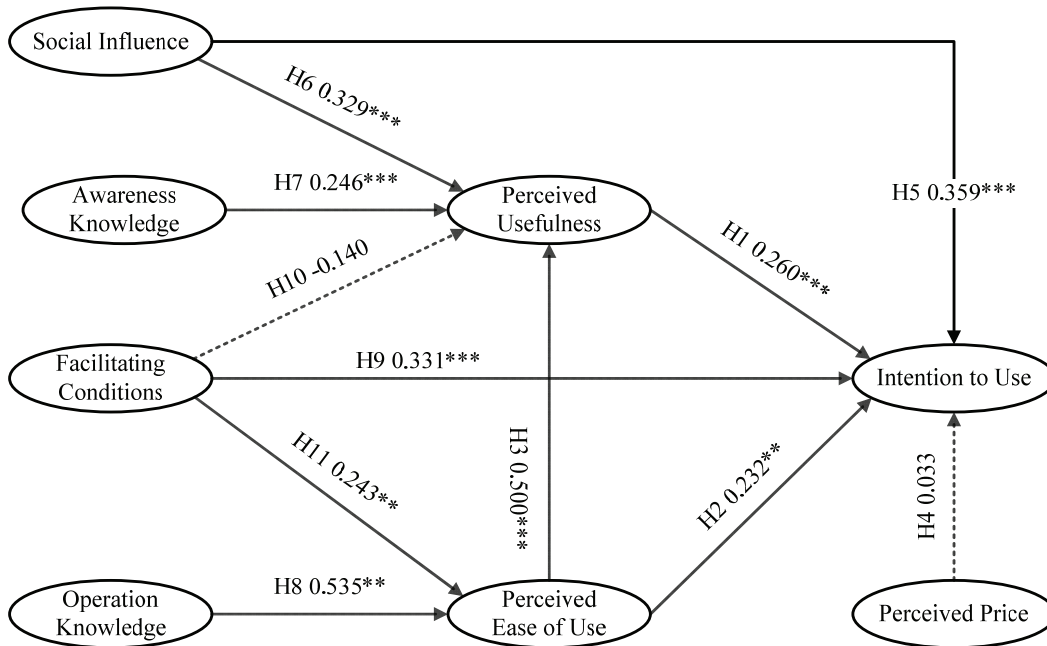
The majority of respondents in this study are male (64.81%), over half of the respondents are between 21-30 years of age (51.22%) (followed by 31-40 years of age (18.12%)), students (31.71%), members of the IT industry (16.38%) and service industry (14.98%) are the top three occupations represented, the education level of the respondents is generally college and above, including graduate school (94.42%), most reside in the Northern part of Taiwan (67.94 %) (followed by Southern Taiwan (19.86%)), and the greatest portion of respondents have a monthly disposable income up to NTD 10,000 (28.92%) (followed by NTD 30,000-49,999 (27.87%), then NTD 10,000-29,999 (24.39%)).

In relation to usage of cellular phones; the average monthly phone bill of respondents is NTD 200-799 (49.83%, with 16.72% of that being NTD 200-399), 32.06% spend more than NTD 1,000 (with 14.63% being NTD 1200-1399 per month). As to reasonable monthly charge for mobile internet access, most respondents spend NTD 200-399 (39.72%), followed by NTD 400-599 (33.10%). The majority of respondents had no experience with QR code services (54.36%), while 45.64% had had some experience with QR code services. Most respondents were willing to purchase a smart phone or already owned one - at 83.97%, the percentage is quite high.

In the questionnaire, the question relating to the use of QR code application services was a multiple-choice question; in the order for the most responses, the top three services used are information about stores & tourism (74.22%), coupon download (71.43%) and fast input of business card and phonebook/contact information (70.03%).

5.2 Structural Equation Models Analysis

Following on from the appropriate analysis of reliability, validity, and model fitness for the research model in this study, With respect to the framework of research model and path analysis of the hypotheses in order to test the hypotheses and reveal the correlation between constructs. In respect of the path analysis, each path coefficient is shown in Figure 3. The t-value of each hypothesis is greater than 2.58, thereby reaching the $p < 0.01$ standard, with the exception of hypothesis H4: Perceived Price will influence Intention to Use, the t-value of which is 0.672 which is less than absolute value 1.96, and hypothesis H10: Facilitating Conditions will influence Perceived Usefulness, the t-value of which is -0.208 which is less than absolute value 1.96. Therefore, hypothesis H4 and H10 are untenable and therefore represented by a dotted line in Figure 4. The rest of hypotheses in this study are true.



Note. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; Dotted line represents a failed hypothesis

Figure.4 Path coefficients of TAM model

Constructs	Influence on Intention to Use		
	Indirect Influence	Direct Influence	Total
Social Influence	0.086	0.359	0.445
Facilitating Conditions	0.088	0.331	0.419
Perceived Ease of Use	0.130	0.232	0.362
Perceived Usefulness	NA	0.260	0.260
Operation Knowledge	0.194	NA	0.194
Awareness Knowledge	0.064	NA	0.064
Perceived Price	NA	NA	NA

Note. NA stands for 'No Effect'

Table 1. The influences of study constructs on intention to use

Hypothesis H4: Perceived Price will influence Intention to Use is untenable as to the cost of using QR code equals the cost of using mobile internet. Domestic telecommunication carriers already included 'unlimited mobile internet using as part of a smart phone package, and the monthly phone bill is about NTD 700~1,000. There is no direct impact on 'Intention to Use' in connection with of QR code use, although the mean from the survey results relating to reasonable mobile networks access charges is 2.67 (1 being totally unacceptable, 7 being complete reasonable), so the current mobile internet access charge tends to be perceived as unacceptable. Consumer dissatisfaction with mobile internet charges does not directly influence the willingness of an individual to use QR code, but may affect the use of mobile internet services, which in turn affects the actual usage of QR code.

Hypothesis H10: Facilitating Conditions will influence Perceived Usefulness is not tenable irrespective of whether the user has a QR code supported cellular phone or not, and will not affect his/her idea of usefulness of QR code, but will affect the "Ease of Use" for of QR code, as well as the "Intention to Use".

After determining whether each hypothesis is true or false, we turn to the analysis of the influence on 'Intention to Use' of each path. The calculation of influence is divided into "direct" and "indirect" influences; "direct influence" is the coefficient of construct path directly to 'Intention to Use'; "indirect influence" is one construct through the path of another construct influencing the 'Intention to Use'. We multiply the coefficient of two constructs, and the sum of coefficient from both 'direct influence' and 'indirect influence' is the total influence. Since hypotheses H4 and H10 are untenable, they are excluded from consideration. Influence of construct on "Intention to Use" is listed by order in Table 1. As can be seen in Table 1, significant influencing factors on 'Intention to Use' are "Social Influence" (0.445), followed by "Facilitating Conditions" (0.419), then "Perceived Ease of Use" (0.362) and "Perceived Usefulness" (0.260) (determined with regard to direct influence to 'Intention to Use', even though the coefficient of "Perceived Usefulness" is higher than "Perceived Ease of Use", but the level of "Perceived Ease of Use" will affect "Perceived Usefulness" and then affect the "Intention to Use"). The construct of "Perceived Price" is not calculated due to failure to meet the standard of a tenable hypothesis.

6 CONCLUSIONS

The survey conducted as part of this study found current domestic users' "Awareness Knowledge" of QR code averages 5.41 (on a scale from 1 to 7 points), while "Operation Knowledge" is a bit lower at 4.49. Willingness to acquire more information in relation to QR code and hope to use QR code in daily life averaged between 5.41 and 5.24 (on a scale from 1 to 7 points), which is in an acceptable range. The major influencing factors to 'Intention to Use' are "Social Influence" and "Facilitating Conditions", followed by "Perceived Ease of Use" and "Perceived Usefulness". The results of this study highlight and reflect the circumstances that occurred when QR code services were introduced in Japan. Because the mobile phones in Japan were offered by telecommunication carriers, decoding software for QR code was already built-in with the phone, and all carriers strongly publicized the services and functions of QR code in television commercials and printed media at the time of implementation. In contrast, carriers and mobile phone makers in Taiwan are not integrated, no built-in decoding software was offered, and no advertising on television or in printed media took place when QR code was introduced, so the general public knew nothing about QR code even though the services are widely offered.

New smart phones that are launched are preloaded with QR code decoding software. With the growing market share of smart phones, most of the new phone models are smart phones; those members of the general public willing to purchase a smart phone accounted for 83.97% of the survey participants in this study. This take-up of new smart phones helps develop the "Facilitating Conditions" in Taiwan and, coupled with the gradual exposure of QR code in the promotion and merchandise in the convenience stores, the "Awareness Knowledge" of QR code for the people in Taiwan is increasing.

Through the survey and validated structural model, our proposals to the Taiwan government and telecommunication carriers are as follows: (1) Utilizing mass media to promote QR code usage and create social influence. (2) From the survey conducted in this study, reasonable monthly charge for wireless internet access is perceived to be NTD 400-599 or less; the charges associated with mobile internet services is in downward trend and the introduction of WiMAX (4G) mobile internet services will lead to lower wireless internet access charges. The development of applications for mobile internet would be encouraged if the charges are within acceptable ranges for the general population in Taiwan. (3) The use of QR code related applications will be assisted by the continued popularity of smart phones; application software is no longer restricted to download from computer, it can be downloaded and installed directly through an application store which also helps to make up for operational knowledge related deficiencies. (4) Based on the survey conducted, from the perspective of the general public in Taiwan, the required services utilizing QR code are not purely informational; if there's a combination of store information, navigation, coupon and added features of merchandise and ticket purchase, the cost of paper can be saved and the connection between the potential consumer and the store can be hastened, which promotes successful marketing may bring about more business opportunities.

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