

*Full Length Research Paper*

# **A TAM-based study on senior citizens' digital learning and user behavioral intention toward use of broadband network technology services provided via television**

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Accepted 11 May, 2011

**As population aging is a growing phenomenon in the 21<sup>st</sup> century, products and services aimed at the elderly have emerged one after the other. Great market opportunities in relation to senior citizens have attracted increasing investment from industries. Governments across the globe are making efforts to work out a variety of programs to meet the demands. Among them, the needs for information technology learning, and digital and mental growth are regarded as the focus of future social and economic development. The main purpose of this study is to investigate senior citizens' behavioral intention toward using broadband network services provided via television. Based on the technology acceptance model (TAM), a model of senior citizens' recognition of digital broadband network service technology available through television will be developed in this paper to establish an empirical understanding of the factors influencing the use and acceptance of innovative technology service products by senior citizens. The results of this study are described in three aspects as follows: 1. perceived ease of use, social norms, mind-stimulating playfulness and product features are variables that have significant positive influence on perceived usefulness; 2. social norms and product features are variables that have significant positive influence on perceived ease of use; 3. perceived usefulness, perceived ease of use, social norms and network externality are variables that have significant positive influence on user behavioral intention.**

**Key words:** Technology acceptance model, senior citizens, digital learning, user behavioral intention.

## **INTRODUCTION**

With its massive population, Asia has served as the driving engine behind global economic progress. However, rapid change of population structure will soon weaken the labor force in Asia and result in economic and market setbacks. Productivity and consuming power will be affected to a considerable extent. Industries must keep a close watch on the tendency and create new economic progress by gearing their production in line with the demands of aging society. According to the estimation of Industrial Economics and Knowledge Center (IEK), by

2025, the scale of the market for senior citizen-related industries can grow to USD 108.9 billion. Compared to the USD 24.6 billion in 2001, the increase will be around 4.5 times. In addition, Taiwan's Ministry of Economic Affairs has also estimated that the number of industries related to retiree and elderly care will expand to 50, with a total investment reaching USD 106 billion. As population aging continues in the 21<sup>st</sup> century, more and more products and services for the elderly will be required and immense business opportunities in relation to senior citizens have drawn increasing investment all around the world, in areas such as commodities, health and medical care, banking and insurance, as well as education and playfulness for senior citizens.

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In 2008, personal computer equipment and digital applications in Taiwan were already a part of life for most people. According to statistics from the Directorate-General of Budget, Accounting and Statistics (DGBAS), by the end of 2008, the number of personal computers already amounted to 10.41 million, at about one computer per 2.2 persons, indicating growing prevalence of digital application equipment. Data from DGBAS also show that PCs in private homes formed the largest proportion, accounting for 60%, while those used in enterprises, government agencies and schools represented the remaining 40%. Use of computers in private homes was obviously a very common practice. In broadband internet connection, as 84.6% of private homes had computers, it means three out of every four homes (77.5%) could have access to the internet, making Taiwan one of the regions in the world where broadband services were readily available.

Examination of related surveys reveals a rapid decrease in use of broadband services by people over 50 years of age. Digital information gaps between various age groups are extremely large and the "digital divide" phenomenon exists between generations. In particular, senior citizens' uneasiness with computers and getting online makes them abstain from using information services. According to the World Health Organization's definition, when the number of people over 65 years old in a country reaches 7% its total population, it is an aging society. The birthrates in Taiwan began to slide in 1991 while, in contrast, the population of older people started to increase. By 1993, the population of people over 65 years of age already exceeded 7% and Taiwan was already an aging society. Problems derived from aging population are issues that modern day government agencies cannot ignore. Survey results from the Department of Health in 2008 show that the elderly population in Taiwan will reach 14% and Taiwan will officially become a country of old people by 2019, which is only 9 years away. Among issues regarding aging society, government plans have mostly been targeted at "active aging" and "disability prevention" by setting up health care programs to forestall physical deterioration, disabilities, falls, bone fractures, depression and suicides, as well as to enhance older people's health and physical strength. In comparison, however, not much has been done for senior citizens' information learning needs, digital entertainment and mental growth.

The so-called "senior citizens" is mainly referred to people born during the post-WWII baby boom starting around 1946. Most of them have received basic school education, possess basic knowledge, and are rather independent and active. As an island of technology with information and service industries as the core of its progress, Taiwan should encourage development of technology services, especially to meet the demands of upper middle-aged people by designing technology services that this population requires. While opening up a new

information service market aimed at older citizens, more job opportunities will also be generated.

Most of the researches in the effect of using information technology on user behavior were based on the Technology Acceptance Model (TAM) developed by Davis et al. (1989). They discussed the effect of users on behavioral intention toward information technology from the viewpoint of technology acceptance. Among those researches, there were few taking the senior citizens as the objects of study, and few describe senior citizens behavioral intention toward information technology. The researches on information needs and user behavior of senior citizens should be paid more attention while most countries have been facing an aging society.

Instead of computer mouse, the senior citizens can easily use a remote control to operate television broadband network technology services. The design is to help senior citizens use information technology product. Therefore, the study discusses senior citizens' behavior intention toward use of broadband network technology service via television from the viewpoint of technology acceptance.

The TAM consists of two beliefs in information technology, perceived usefulness and perceived ease of use, which determine user behavior intention. The perceived usefulness and perceived ease of use are affected by various external variables. The model must be amended while applied to different user behavior researches. While the study takes senior citizens as the research objects, the model was amended to include four external variables (social norms, mind-stimulating playfulness, product features and network externality) that focus on senior citizens' information need in the part of technology characteristics. The main purpose of this study is to investigate senior citizens' behavioral intention toward using digital learning service software technology.

The subjects of this study are industries related to senior citizens. The questionnaire survey method will be employed to examine the influence of digital learning through broadband networks via television on senior citizens' acceptance of innovative technologies in order to acquire a better picture of the developments of the industries and the behavior of the consumers, as well as to locate the factors of influence in this fast-changing society where information communication is growing at an incredible speed. The results may serve as references for the industries when they formulate their business strategies. The purposes of this study are as follows:

1. Through examination of related literature, develop a model of senior citizens' behavioral intention toward use of broadband network services via television for digital learning through innovative technologies.
2. Identify the interrelations between the variables in the Technology acceptance model of senior citizens' perception toward digital learning through broadband network services provided via television, such as perceived

usefulness, perceived ease of use, user behavioral intention and external variables.

## LITERATURE REVIEW

### Senior citizens and tendencies of related markets

People born within 10 years after World War II are now slowly approaching retirement age. Their income and education are much better than their previous generation. It is therefore quite appropriate to call these elderly citizens "senior citizens". Their life expectancy is longer and their financial capacity is better than those in the past. They are consumers capable of making their own decisions. They control their own life, which appears to be rather content. They pursue physical fitness and adventures. Compared to the elderly in the more traditional society in the past, they are more energetic and happy to learn new things (Mathur and Schiffman, 1998).

From the ongoing, the definition of "senior citizens" included as subjects of research in this study is in line with the age qualification of students most evergreen learning institutes in Taiwan adopt – people over 55 years old – especially those who are physically fit, financially capable, energetic, and fond of learning new things.

According to the findings of the IEK from examination of international examples, many countries have already begun to promote industries related to senior citizens. The initiative covered more than just care and medical services for older people. The chief objective was to establish a sound environment for care and services for the elderly, make good use of their accumulated wealth, knowledge and skills, and labor capacity to build a new driving momentum to boost the economy. Aging population is an avoidable trend. In Taiwan, besides related welfare measures, the enterprises should also seize the upcoming opportunities and begin to develop businesses in relation to senior citizens.

Innovative Service Technology Digital Learning – Broadband Network via Television. According to the definition by the American Society for Training and Development (ASTD), digital learning encompasses a vast scope. Use of the internet, satellite broadcasting, interactive television and compact discs to perform teaching is all included. Gartner Group concurs with the view, considering digital learning a kind of distance education by using the internet as an interface to transmit digital teaching material. Another market research organization, International Data Corporation (IDC), also upholds the definition and deems digital learning as the process of transmitting training courses or services to learners through the Internet or intranet systems in schools and companies. The National Science Council of Taiwan defined e-learning as use of digital instruments to acquire contents of digital teaching material through cable or wireless networks to conduct online or off-line learning activities.

In this study, digital learning is regarded as a mode of distance education, learning activities conducted by using online platforms to communicate. Once a learner logs in, he or she is able to undergo the process of synchronized or non-synchronized learning activities.

The broadband networks referred to in this study are defined as approaches capable of transmitting digital visual-audio multimedia data, including ADSL, and optic fiber broadband network access. At the same time, the "broadband network application services" or "broadband application services" means a variety of services and applications conducted based on broadband networks, while broadband network application services "provided via television" refers to access to information and services normally "acquired through computers" by "watching TV," such as broadband service systems designated for senior citizens and designated services for senior citizens presented in large images, large fonts and rich contents that senior citizens can simply use a remote control to operate, select, read and view.

The Technology Acceptance Model (TAM) is a device designed to interpret and predict the influence of users' cognitive and emotional factors on their acceptance of technology. It was developed by Davis et al. (1989) based on the Theory of Reasoned Action (TRA) by Fishbain and Ajzen (1975) and Ajzen's Theory of Planned Behavior (Ajzen, 1985).

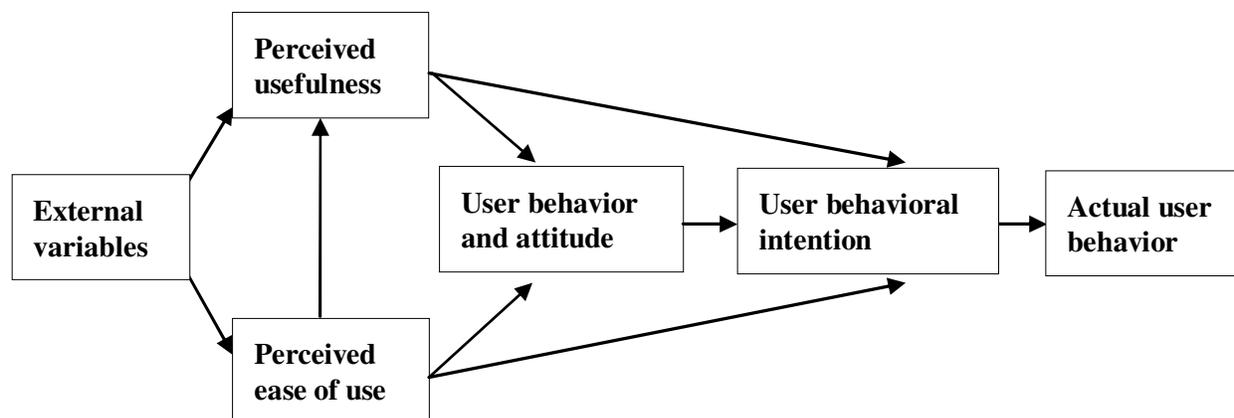
The objective was to provide a general interpretation of the decisive factors in the degree of users' acceptance of information technology, using theories to verify and explain most behavior in use of technology.

Research by Davis et al. (1989) indicated that the most fundamental conviction that had an effect on attitude included two cognitive aspects – perceived usefulness and perceived ease of use. They would have an impact on the attitude of the user toward new technology and subsequently affect the user's behavioral intention. Furthermore, study by Davis (1989) suggested that perceived ease of use would have indirect influence on users' behavior through Perceived Usefulness.

Therefore, perceived ease of use was an important variable that had an effect on perceived usefulness. Other variables included external factors that might have an impact on the usefulness and ease of use, potential users perceive, and these external variables would influence users' cognitive conviction through recognition of usefulness and ease of use (Igbaria et al., 1995; Szajna, 1996; Venkatesh and Davis, 1996). Their relations are as shown in Figure 1.

### External variables to TAM

Davis (1989) suggested that the researches on technology acceptance should be based on TAM theory, and should join external variables to reinforce the results. The study takes social norms, mind-stimulating playfulness, product features and network externality as external



**Figure 1.** Technology Acceptance model (TAM) (Davis F. D., Bagozzi R. P., and Warshaw P. R.. (1989) "User Acceptance of Computer Technology: A Comparison of Two Theoretical Models").

variables to investigate the influence factors and acceptance of senior citizens toward broaden network technology service via television

According to theory of conformity, social norms will influence group members, and change attitude and behavior (Bernheim, 1994). Social norms are common belief and acceptable standard of behavior of a society. The enforcement of social norms depends on result of expectation and social disapproval or punishment for norm violations. Therefore, social norms are external behavior norms. Schwartz and Howard (1982) indicated that the "social" in the social norm expresses the fact and base on group expectation, external reward and punishment, and norm reinforcement.

The social norm can be written or unwritten, but the standards must be accepted and complied with. Social cognition on norms is only in the law and regulation aspect. But social norm covers social culture aspect, such as customs, public opinion, and social support. The social norm influences individual behavior through social pressure (Engel et al., 1995; Schwartz, 1977). Money is not usually the main consideration when senior citizens have social contact with friends, but the pressure and recognition from their peers are the most consideration. Under the situation of "when everyone has" or "every will have", they may think they should have same one or learn to use the facility. Therefore, the study includes social norms into the model.

Barnett (1991) concluded two definitions for playfulness, trait of playfulness and state of playfulness. The trait of playfulness is regarded as an individual motive characteristic and more stable while the state of playfulness emphasizes the trait of interaction of individual with environment. The state of playfulness represents a comparatively permanent personal trait and a short-term feeling status emerges from perception. The study adopts the phrase of "mind-stimulating playfulness" that contains the meanings of playfulness and mind-stimulating. The

senior citizens are not only learning and obtaining information through the broaden network services via television but also have fun and joy. Therefore, mind-stimulating playfulness is adopted as an external variable in this study.

Moon and Kim (2001) adopted TAM, analyzed the motivation factors of using World Wide Web in their research of web user behavior. Except ease-of-use and usefulness, perceived playfulness was introduced as a external variable of web user behavior. Perceived playfulness included contraction, curiosity, and joyfulness.

The research found that playfulness has positive influence on user behavior of World Wide Web.

From the viewpoint of marketing, the likelihood of a repeat visit to a web site is enhanced when the visitors find the visit enjoyable (Rice, 1997). From the aspect of media, the more playfulness provided by internet, the more users will visit (Eighmey and McCord, 1998). Perceived playfulness has an import influence on user of internet and information technology. The product of television broaden network provides functions of digital leaning and entertainment. The factor of mind-stimulating playfulness has a significant influence on the acceptance of technology products of senior citizens.

A product is the integration of some features (such as characteristics, functions, benefits) and can be sold and interchanged. It is the integration of tangible attributes (such as package, color, size) and intangible attributes (such as pricing, goodwill, product image). It can be a concept, service, goods or the combination of the three. Kotler (1994) indicated that a product is anything available to markets, can be perceived, bought, used, or consumed. In a broader sense, a product is anything can be marketed, including tangible goods, service, people, place, organization, and concept. Chang (1996) concluded the attributes of products that are suitable for selling in the internet; 1) no requirement of physical distribution, can be tried directly and lower price, 2) consumers do not

need to inspect the products personally, 3) consumers are familiar with the products, 4) provide detail specifications and follow-up instruction for information or high-tech products. Product feature is an important variable in analyzing consumer behavior. The study defines the product features of the television broadband network services as diversity, convenience and reasonable price.

The early researches on network externality focused on telecommunication industry (Rohlf's, 1974), Katz and Shapiro (1985) extended it to information industry. Katz and Shapiro (1985) defined network externality as the augmentation of the effect of a product as a result of increase of the product benefits due to growing numbers of users, such as the usage of telephone network, the compatibility of hardware and software. Direct network externality is generated through the direct effect of the increasing number of users of compatible products. The telephone users' benefit is generated by other users connecting to the same network. Indirect network externality generated through complementary goods being more plentiful and lower in price as the number of users of the good increases. The example is that the application of a software increases as the number of computers of a particular type increases. The value of network will increase in geometric progression as the users increase. The minor difference in the feature of network externality will result in different consumer decision behavior. The feature is one of major influence factors in profit making. The study includes network externality into the research model.

### Study hypotheses

As this study is primarily aimed to analyze senior citizens' behavioral intention toward use of broadband service technology provided via television, the following hypotheses are proposed in line with the framework of study established based on the technology acceptance model:

#### ***Perceived usefulness, perceived ease of use and behavioral intention***

According to the definition by Davis et al. (1989), perceived usefulness means, in an organized circumstance, the user subjectively considers use of a specific system is likely to facilitate his or her work performance. It has influence on the user's behavioral intention toward the system (Davis et al., 1989). Perceived ease of use on the other hand, refers to a potential user's conviction that a certain information system is easier to learn and operate and the instructions are clear. It has a positive and direct impact on perceived usefulness. Literature on TAM all indicates that the user's behavioral intention will fall under the sway of perceived usefulness and perceived ease of use (Adams et al. 1992; Chau et al., 2001; Davis, 1989;

Igbaria et al., 1995; Lin and Lu, 2000; Morris and Venkatesh, 2000; Oh and Kim, 2003; Venkatesh and Davis, 2000). Based on the foregoing, the following hypotheses are proposed:

H<sub>1</sub>: Senior citizens' perceived usefulness has positive influence on their behavioral intention toward use of broadband network technology services provided via television.

H<sub>2</sub>: Senior citizens' perceived ease of use has positive influence on their behavioral intention toward use of broadband network technology services provided via television.

H<sub>3</sub>: Senior citizens' perceived ease has positive influence on their perceived usefulness toward use of broadband network technology services provided via television.

#### ***Social norms***

It is pointed out in the Theory of Reasoned Action (TRA) that an individual's behavioral intention is obviously affected by social norms and attitudes. Empirically, social norms proved to have a significant impact on individual behavioral intention toward use of information technology (Liker and Sindi, 1997; Lucas and Spitler, 2000; Venkatesh and Davis, 1996). The influence of social norms comes from reference groups, which mean people and individuals that mean something to the user (Fisherbein and Ajzen, 1975). The study of Tan and Teo (2000) suggested that reference groups include friends, family members, classmates, colleagues, and so forth. They have influence on an individual's use of information technology. As a result, social norms make an important factor in an individual's use of technology services. In other words, the individual is under the influence of the members of the reference groups when deciding whether or not to use an information technology service. Based on the foregoing, the following hypotheses are established:

H<sub>4</sub>: Social norms have positive influence on senior citizens' a) perceived usefulness and b) perceived ease of use toward broadband network technology services provided via television.

H<sub>5</sub>: Social norms have positive influence on senior citizens' behavioral intention toward use of broadband network technology services provided via television.

#### ***Mind-stimulating playfulness***

Fratiglioni et al. (2004) indicated that senior citizens need more activity arrangements to stimulate their senses. Enriched environment can enhance brain activity and postpone aging. Moyles (1988) believes that games will develop potential and build up confidence. In view of this, senior citizens may accept the services provided by

broadband network technology to prevent and postpone aging and build up confidence. Mind-stimulating playfulness is adopted as an external variable in this study. The quality of mind-stimulating playfulness refers to senior citizens' perception of the degree of fun in learning knowledge through digital broadband services provided via television. To verify such influence, the following hypothesis is proposed:

H<sub>6</sub>: The quality of mind-stimulating playfulness has positive influence on senior citizens' a) perceived usefulness and b) perceived ease of use toward broadband network technology services provided via television.

### **Product features**

The factors of influence of product features taken into account in this study include: the diversity, convenience and price of broadband network services for senior citizens provided via television. The degree of their influence on the perceived usefulness and perceived ease of users of such services are investigated to understand the influence of each of these factors on perceived usefulness and perceived ease of use. Consequently, the following hypothesis is proposed:

H<sub>7</sub>: Product features have positive influence on senior citizens' a) perceived usefulness and b) perceived ease of use toward broadband network technology services provided via television.

### **Network externality**

There have been many studies on network externality since mid-1980s. In recent years, most studies related to products with network externality characteristics have mostly been based on the assumption that increased numbers of users of the same product could bring the old users external benefits. As a consequence, the number of users has been added in the utility function to identify consumers' most appropriate decision behavior under the influence of network externality (Katz and Shapiro, 1985). Katz and Shapiro (1985) defined network externality as the augmentation of the effect of a product as a result of increase of the benefits of the product due to growing numbers of users. According to TAM-related studies in the past, network externality has positive influence on perceived usefulness and perceived ease of use (Pae and Hyun, 2002; Wang et al., 2004). On top of this, study by Davis et al. (1989) also suggested that perceived usefulness and perceived ease of use have positive influence on behavioral intention. Therefore, the following hypotheses are proposed:

H<sub>8</sub>: The network externality of broadband network

technology services provided via television has positive influence on senior citizens' a) perceived usefulness and b) perceived ease of use.

H<sub>9</sub>: The network externality of broadband network technology services provided via television has positive influence on senior citizens' behavioral intention.

## **METHODOLOGY**

### **Framework of study**

The main purpose of this study is to examine the factors of influence on senior citizens' recognition and acceptance of broadband network technology services via television. Hu et al. (1999) suggested that use of the technology acceptance model as the research foundation should be complemented with other variables in accordance with the particular features of the technology product being studied in order to increase the explanatory power of the model. This study adopts the technology acceptance model established by Davis (1989) as the foundation, with addition of social norms, mind-stimulating playfulness, product features and network externality as four external variables, to establish the "technology acceptance model of designated digital learning services through broadband networks via television" as the framework of this study, as shown in Figure 2.

### **Questionnaire design and evaluation**

This study is intended to investigate the factors in senior citizens' behavior in use of broadband networks provided via television (any services provided through a set top box on the TV, such as Chung Hwa Telecom's MOD, Vee Teclcom's services, etc., in Taiwan). The questionnaire survey method is adopted to collect needed data. The questionnaire is designed by referring to questionnaires established by Davis et al. (1989), Fishbein and Ajzen (1975), Ducoffe (1996) and Oh and Kim. (2003). A 7-point Likert scale is applied for questionnaire rating. The design and evaluation of the questionnaire are as shown in Table 1.

## **RESULTS**

The targets of study are senior citizens attending evergreen learning institutes in community universities in northern Taiwan. A total of 600 copies of questionnaire are administered, 88.33% of the questionnaires retrieved are valid. The majority of the targets of study are between 61 and 70 years old (75%). Females account for 67%.

Factor analysis and reliability analysis on each aspect are performed to evaluate the validity and reliability of this study. The Cronbach's  $\alpha$  value is adopted for reliability analysis and, as shown in Table 2, the results reveal the Cronbach's  $\alpha$  of every construct surpasses 0.7, indicating that the reliability of the measurement of each aspect of this study is acceptable.

Exploratory factor analysis is employed to test the aspect validity of each question for validity assessment. The resulted KMO value is 0.881, an indication that the sampling is extremely appropriate. The eigenvalues of the factors and the total explained variance ratios are as

**Table 1.** Questionnaire design and evaluation.

<b>Aspect of study</b>	<b>Operational definition</b>	<b>Aspect questions</b>	<b>Source of reference</b>
User behavioral intention	Users' subjective decision to use broadband services provided via television in the future	<ol style="list-style-type: none"> <li>1. If I have the access to digital broadband services provided via television, I will use them.</li> <li>2. If I am given the opportunity to use digital broadband services provided via television, I think I'll use them.</li> <li>3. We plan to use digital broadband services provided via television for TV watching and Internet access in the future.</li> </ol>	Davis et al. (1989)
Perceived usefulness	Broadband services provided via television regarded as capable of fulfilling demands for visual-audio data	<ol style="list-style-type: none"> <li>1. I think broadband services provided via television makes "TV watching" and Internet access convenient.</li> <li>2. Digital broadband services provided via television can make me more efficient in TV watching and getting online.</li> <li>3. Digital broadband services provided via television can satisfy my needs for playfulness and information acquisition.</li> <li>4. In my life, digital broadband services provided via television are useful.</li> </ol>	Davis et al. (1989)
Perceived ease of use	Easiness of learning and operating broadband services provided via television	<ol style="list-style-type: none"> <li>1. It is easy for me to learn to use digital broadband services provided via television.</li> <li>2. I can easily use digital broadband services provided via television to find programs I wan to watch.</li> <li>3. The instructions for digital broadband services provided via television are clear and comprehensible.</li> <li>4. I don't need to spend too much energy to use digital broadband services provided via television.</li> </ol>	Davis et al. (1989)
Social norms	Users' conviction in use of digital broadband services provided via television as capable of improving his or her reputation or other people's expectation of him or her.	<ol style="list-style-type: none"> <li>1. I think my friends (or family members or colleagues) will identify with my use of broadband digital learning services provided via television.</li> <li>2. I think my friends (or family members or colleagues) will agree that it is important for me to use broadband digital learning services.</li> <li>3. I think my friends (or family members or colleagues) will support my use of broadband digital learning services provided via television.</li> </ol>	Fishbein and Ajzen (1975)
Quality of mind-stimulating playfulness	The interest and fun in learning knowledge through digital broadband services provided via television	<ol style="list-style-type: none"> <li>1. I consider use of digital broadband services provided via television pleasant and interesting.</li> <li>2. I consider use of digital broadband services provided via television novel and curious.</li> <li>3. I think use of digital broadband services provided via television can bring information and joy.</li> </ol>	Ducoffe (1996)
Product features	Diversity, convenience and price of the products of broadband network services provided via television	<ol style="list-style-type: none"> <li>1. My provider of digital broadband services via television offers diverse products.</li> <li>2. My provider of digital broadband services via television offers free trial of its new products.</li> <li>3. My provider of digital broadband services via television offers new products at reasonable prices.</li> <li>4. My provider of digital broadband services via television offers online access for product queries.</li> </ol>	Cai (2006)

Table 1. Contd.

Network externality	Increase of benefits and peripheral products of broadband services provided via television along with growth in numbers of users	<ol style="list-style-type: none"> <li>1. I will be able to perceive more benefits as the number of users of digital broadband service provided via television grows.</li> <li>2. I believe more and more related software and hardware will be developed in the future as the number of users of digital broadband services provided via television grows.</li> <li>3. According to my observation, there are a rather large number of people using digital broadband services provided via television.</li> </ol>	Oh et al. (2003)
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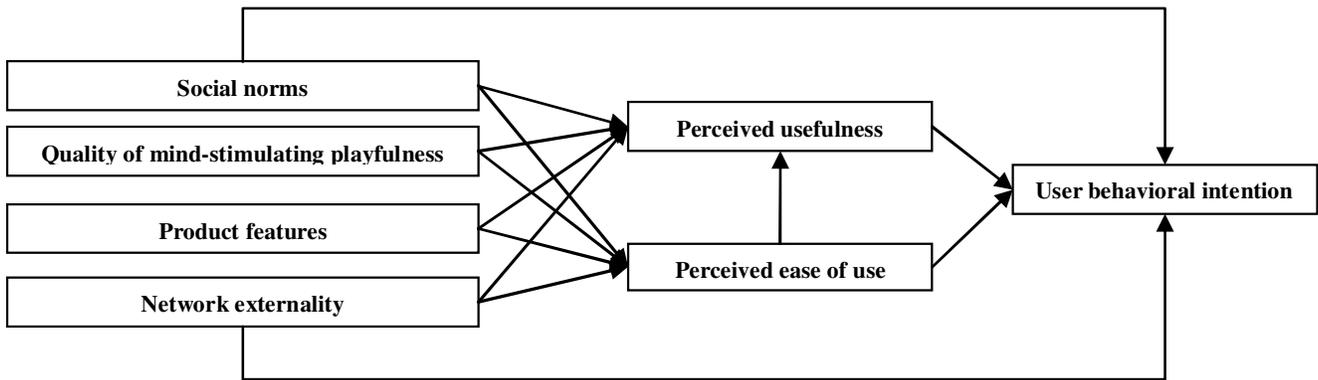


Figure 2. Framework of study.

shown in the table, arranged in the descending order from 16.456 of the first factor to 7.152 of the seventh factor. The cumulative explained variance of the seven factors comes to 78.989%. After rotation of factor loadings and removal of questions with an absolute value below 0.5 (PU4 and NE3), 22 questions are analyzed. The results are as expected (Table 2).

Before regression analysis is conducted, correlation analysis is performed on every aspect of this study. As demonstrated in Table 3, the correlation between the seven aspects proves positive and achieves statistical significant levels. Therefore, the results of correlation analysis conform to the framework of this study.

Before the following regression analysis is performed, the degree of self-correlation of the residual of each factor has to be tested. When the degree of self-correlation is high, the efficiency of prediction may be underestimated. Therefore, DW statistic measures are applied to test the self-correlation of each factor. The closer the DW statistic approaches 2, the less self-correlation there is between residual terms. On the other hand, when the DW statistic comes close to 4 or 0, it means either negative or positive self-correlation exists between residual terms. As shown in Table 4, except the DW value of user behavioral intention in Table 4 appears to be a bit large, the DW values of all factor aspects of this study are all around 2, indicating there is no self-

correlation between residual terms and regression analysis can be conducted.

Multiple regression is applied in this study to verify the mutual influence between the variables in the framework of this study. The results of statistical analysis are as shown in Table 5.

First of all, in the factors of influence on user behavioral intention, perceived usefulness, perceived ease of use, social norms and network externality are all variables having significant positive influence on user behavioral intention. Therefore, H1, H2, H5 and H9 sustain. The variance explained is 34.7%.

Secondly, in factors of influence on perceived usefulness, perceived ease of use, social norms, mind-stimulating playfulness and product features are all variables having significant positive influence on perceived usefulness. Therefore H3m, H4am, H6a and H7a sustain. The variance explained is 327.3%.

Lastly, in factors of influence on perceived ease of use, social norms and product features are variables with significant positive influence on perceived ease of use. Therefore, H4b and H7b sustain. The variance explained is 22.1%.

### Conclusions

The framework of this study is a modified version of the

**Table 2.** Factor analysis and reliability analysis.

Question	Factor loading	Variance explained	Eigen value	Name of factor	Cronbach's $\alpha$ Value
PU1 PU2 PU3 PU4 (removed)	16.456	5.675	Perceived usefulness	0.87	16.456
PE1 PE2 PE3 PE4	9.767	1.02	Perceived ease of use	0.79	9.767
BI1 BI2 BI3	9.233	1.13	User behavioral intention	0.94	9.233
SN1 SN2 SN3	10.287	1.565	Social norms	0.89	10.287
WE1 WE2 WE3	13.769	3.012	Quality of mind-stimulating playfulness	0.78	13.769
PC1 PC2 PC3 PC4	12.325	2.962	Product features	0.86	12.325
NE1 NE2 NE3 (removed)	7.152	1.38	Network externality	0.75	7.152
Total cumulative variance explained : 78.989%					

**Table 3.** Pearson correlation coefficient.

Aspect of study	Perceived usefulness	Perceived ease of use	User behavioral intention	Social norms	Mind-stimulating playfulness	Product features
Perceived ease of use	0.246***					
User behavioral intention	0.272***	0.331***				
Social norms	0.285***	0.417***	0.402***			
Mind-stimulating Playfulness	0.259***	0.433***	0.435***	0.336***		
Product features	0.203***	0.345***	0.470***	0.351***	0.436***	
Network externality	0.098***	0.168***	0.421***	0.260***	0.107**	0.207 ***

\*P < 0.1, \*\* P < 0.05, \*\*\*P < 0.01.

technology acceptance model established by Davis (1989), with addition of social norms, quality of stimulating playfulness, product features and network externality. These four external variables have influence on

perceived usefulness and perceived ease of use and, as a result, also have an effect on the behavioral intention toward use of broadband network technology services provided via television. The findings of the study can be

**Table 4.** DW value of all factor aspect.

Variable	Perceived ease of use	Social norms	Quality of mind-stimulating playfulness	Product features	Network externality
Perceived usefulness	1.814	2.051	2.030	1.887	1.982
	Social norms	Quality of mind-stimulating playfulness	Product features	Network externality	
Perceived ease of use	2.074	2.020	1.965	2.102	
	Social norms	Network externality	Perceived usefulness	Perceived ease of use	
User behavioral intention	2.872	2.793	2.168	2.423	

**Table 5.** Regression analysis of perceived usefulness, perceived ease of use and user behavioral intention.

Standardized coefficients	B Value	T Value	F Value	AdjR <sup>2</sup> Value
<b>Factors of influence on user behavioral intention</b>				
Perceived usefulness	0.224	3.923***		
Perceived ease of use	0.239	4.222***	54.106***	0.347
Social norms	0.134	2.705***		
Network externality	0.317	5.881***		
<b>Factor of influence on perceived usefulness</b>				
Perceived ease of use	0.133	2.636***		
Social norms	0.425	8.271***		
Quality of mind-stimulating playfulness	0.087	1.902*	60.496***	0.373
Product features	0.061	1.353*		
Network externality	0.054	1.357		
<b>Factors of influence on perceived ease of use</b>				
Social norms	0.420	8.337***		
Quality of mind-stimulating playfulness	0.038	1.246	13.963**	0.221
Product features	0.100	2.254**		
Network externality	0.047	1.721		

\*p < 0.1 \*\*p < 0.05 \*\*\*p < 0.001.

discussed from three angles. Initially, the findings indicate that perceived ease of use, social norms, mind-stimulating playfulness and product features are all variables with significant positive influence on perceived usefulness. In other words, the stronger consumers perceive broadband network technology services as easy to operate, diversified in service products, interesting and fun, and capable of bringing identification from friends, the more likely they will consider broadband services provided via television as having the capacity to meet their visual-audio needs.

Next, the study results reveal that social norms and product features are variables having significant positive influence on perceived ease of use. This means the stronger consumers perceive broadband network technology services as diversified in service products and beneficial in acquisition of identification from friends, the

more likely they will consider broadband technology products available through television as easy to learn or operate.

Thirdly, perceived usefulness, perceived ease of use, social norms and network externality are external variables that have significant positive influence on user behavioral intention.

The results indicate that the acceptance of information technology of senior citizens is mainly influenced by social norms. Senior citizens are willing to contact with others and are mostly afraid to be forgotten by society. But they think the society expects them to stay at home but do not have much social contacts. They still concern their impression given to other people. Therefore, social norms and social support are major influence factors to senior citizens to accept and adopt a new technology. Combination of the foregoing shows that the quality of

mind-stimulating playfulness has no significant influence on perceived ease of use, meaning that senior citizens will not consider a broadband technology product as easy to learn or operate as a result of their thinking the product as entertaining, educative, interesting and fun. Moreover, network externality also has no significant influence on perceived usefulness and perceived ease of use but its positive influence on user behavioral intention is evident. This outcome implies that users will not consider a broadband network technology service provided via television as more useful or easier to operate because of increases in the number of users of the service in concern. However, as users increase, the interest in using broadband network technology services will grow. As for the positive influence of network externality on user behavioral intention, the result of the study is consistent with those of previous studies (Pae and Hyun, 2002; Wang et al., 2004).

Bases on the features of television broadband technology services and the trait of senior citizens, four external variables of social norms, mind-stimulating playfulness, product features and network externality are included in the study that extend the influence factors of technology acceptance model. In addition, although the TAM is applied extensively in the researches of technology acceptance behaviors, there are few researches that apply the model in senior citizens behaviors. The results can be a reference material for related researches. The study suggests that concerned businesses ought to plan different strategies in line with the consumption characteristics of senior citizens. The outcome of this study shows that the interest of senior citizens in using a certain product will grow as a result of their need of identification from friends and increases in the number of users. Related businesses are therefore recommended to promote their products in community universities, evergreen learning institutes and cultural centers for the elderly. They should sponsor more related group courses and provide free trial hours to attract senior consumers. Eventually, it might create a snowball effect. At the same time, businesses should also establish designated web pages aimed at the needs of senior citizens, such as medical and health care, retirement planning, playfulness for the elderly, and so on, as extra options. As for limitations of study, surveys reveal that the demand of senior citizens for internet access is not any lower than that of other social groups. Nevertheless, being afraid of showing inferior learning performance, being unable to catch up, and losing face, most of them abstain from computers, even reject them. Consequently, a large of number of senior citizens' use the excuse that the technology is too new for them and keep a distance from computers. On the other hand, senior citizens might regard getting online as a cumbersome process, mainly due to the difficulty they have with the mouse. Being unaccustomed and unfamiliar with the control of the mouse naturally reduces their interest in getting online to acquire information. Broadband network technology

products (such as Chung Hwa Telecom's MOD) have come from the concept of replacing computers with television sets. Consumers only have to operate the TV remote control to access information online. Since related broadband network technology service providers were still in the early stage of their development when this study was conducted, only consumers who were already using Chung Hwa Telecom's MOD services could be studied. Therefore, the reasoning about senior citizens' interest in using broadband network technology and related factors of influence could only be based on such limited sources.

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