Extending the TAM Model to Explore the Factors Affecting Intention to Use Telecare Systems

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Abstract—The purpose of the study is to integrate patient trust with the Technology Acceptance Model in order to explore the usage intention model of Telecare systems. The proposed framework is validated with 365 respondents from Nantou County, which is located in Taiwan. The findings show that patient trust (social trust and institutional trust) has significantly positive effects on the perceived ease of use, and perceived usefulness separately, which in turn influence usage intention. This study also confirms that both perceived ease of use and perceived usefulness are important mediators between patient trust and usage intention. According to the statistical results, the proposed model fits very well for the samples. This study emphasizes that hospital managers should pay more attention to building a trusting relationship between the elderly and caregivers, and improving the quality of the system. The integrative viewpoint implies that a successful telecare system is not only an information system but also a service provider/department to the patients. The findings may be used as a theoretical basis for future research and can also offer empirical foresight to the executives and managers of hospitals when they initially introduce and promote the telecare systems into their surrounding community.

Index Terms—Telecare, perceived ease of use, perceived usefulness, social trust, institutional trust

I. INTRODUCTION

In recent years, owing to the influence of relevant socio-economic background factors, the birth rate of infants in each family has also declined year by year. The decline in the birth rate as along with the extension of people’s average lifespan have influenced the phenomenon of the aging demographic structure, which is continuing to be more and more obvious. With the phenomenon of the aging of the population, changes in middle-aged adults and the elderly in their lifestyle patterns and problems with seeking medical advice have been caused, including emergency medical care, life care when physical and mental functions are lost, chronic diseases, and so on. These changes and problems have become crucial medical care issues nowadays. In addition, these care issues reveal the importance of professional fields, such as long-term care and senior health management.

Recently, technical suitability, clinical feasibility, and the costs of medical care services have been improved due to the rapid development of information-related technology and biomedical technology. Currently, many countries have attempted to apply information technology to telecare and to develop other functions, such as the emergency notification of unusual events, medication reminders, physiological recording and monitoring, remote video, and medical consultation by combining medical care and information technology. It is expected that these will reduce medical costs, lower labor costs, and become one of the important potential industries.

However, there are still shortcomings in current studies concerning telecare. Currently, in pilot studies regarding telecare, most of the emphasis is put on the technological aspect in order to stress the construction of the information platform and system. Telecare service is a medical process that includes social and technological interaction. It not only requires evaluating the quality of technology, but it also requires to deeply explore the issues such as related technology in the process of services, social psychology, and management in order to obtain a comprehensive overview of whether telecare is successful or not. In addition, the current progress of telecare is not just home monitoring, it also emphasizes active health management and self-care to advance the abilities of the elderly or patients in health and self-management. Therefore, the perceptions and experiences of the elderly or patients about telecare will influence their degree of acceptance. Hence, to evaluate the technological acceptance of telecare from the perspective of the elderly or patients will advance the successful implementation of telecare. Moreover, many of the
previous relevant studies are limited in scope (medical specific fields) or size (number of samples), and the discussions or contributions to clinical practices of telecare are very limited.

TAM (Technology Acceptance Model) is a well-accepted intention model for predicting and explaining IT usage. TAM identifies that an individual’s system usage depends on two beliefs: perceived ease of use and perceived usefulness. TAM has been found more favorable in many studies [1]. Because TAM is a well-defined model, the proposed model of the study is based on this model to explore the intention to use a telecare system in Taiwan.

In addition, telecare is a novel technology to both the patient and care provider. Most patients experiencing new telecare services have little knowledge of the potential benefits, so they may perceive higher risk, resulting in a reduced disposition to trust the providers. Therefore, it is crucial to explore the issue of patient trust of the telecare system. Accordingly, the purpose of the study is to integrate patient trust factors (social trust and institutional trust), and the TAM model in order to formulate a research model. The proposed research model will be empirically tested using the structural equation modeling (SEM). Through the statistical analysis, we can investigate the relationship between patient trust and TAM factors and, furthermore, find out the important antecedents of usage intention of telecare. In this way, we hope to provide the managers of hospitals and the administrators of the IS department with the insight and reference regarding the management of telecare systems in the future.

II. LITERATURE REVIEW

A. Telecare

Telecare is one of the applied fields for telemedicine technology. Demiris, Doorenbos, and Towle [2] argued that telecare is to utilize video conference or telecommunication technology to advance the communication between patients and health care providers who are geographically separated. Telecare can help senior citizens who are in remote and underserved districts to have access to health care and supportive services.

The content of remote home health care services can roughly include the following aspects: (1) capture of basic physiological information: the capture of basic physiological signals (such as body temperature, heartbeat, number of respirations, systolic blood pressure, diastolic blood pressure, mean blood pressure, electrocardiogram, blood to oxygen ratio, and basic lung function), (2) contact and coordination of care services: including emergency calls for help from home, sending the unusual warning signals, notice of return visit and so on, and (3) assistance in health self-management: assist care receivers to grasp the daily changes of physiological information, do the self-management and tracking well, and take early precautions. In addition to the above functions, some home telecare systems also include: (4) communication and video equipment (such as the video telephone), which can contact case managers to assist patients in their own health management or assist caregivers in the enhancement of care skills, and (5) health education websites set up by medical institutions to provide patients or their family members with online consultations or the access to knowledge of health education.

According to Doughty, Cameron, and Garner [3], the telecare system can be divided into three generations. The first-generation system roughly emerged between 1980 and 1990, including a home mainframe, an emergency button, and a call center that receives messages. If an emergency happens, press the emergency button. Then, the call center can be reached through the home mainframe for the rescue or assistance. The second-generation system was roughly in late 1990. It utilizes infrared sensors to continuously monitor the daily activities and physiological indicators of senior citizens, or it is called “smart home”. When the physiological indicators are out of the normal range, the system will automatically activate the alarm. The goal of the third-generation system is to improve the health and living quality of senior citizens. In addition to continuously using infrared sensors, the delivery of images is added. Senior citizens can participate in wider community groups through the usage of information and communication technology to enable families to become the focus of community health care.

In view of people’s increasing need for long-term care in our country, the Department of Health, Executive Yuan, R.O.C. (Taiwan) started promoting the “Telecare Pilot Project” in 2007. Through telecare along with the combination and application of information and communication technology, three telecare service models, including community-based telecare, home-based telecare, and institution-based telecare, were developed. Moreover, an integration platform of telecare information was established. A summary of the literature review and the observation of industrial trends show that telecare is currently no longer just restricted to home monitoring. It also has the functions of advancing the active participation in self-health management, self-care, health education videos, and pharmaceutical consultations. It is of tremendous benefit for the security and independence of living quality of senior citizens and chronic patients.

B. Theory of Reasoned Action (TRA) and Technology Acceptance Model (TAM)

The theory of reasoned action (TRA) is developed to predict and explain human beings’ consciously intended behavior in the social psychological field [4]. According to TRA, an individual’s specified behavior is determined by behavioral intention to perform the behavior, whereas the intention is jointly determined by the person’s attitude and subjective norm concerning the behavior. The attitude toward behavior is an individual’s evaluative effect on performing the behavior, and the subjective norm is an individual’s perception that important referents of him think he should or should not perform the target behavior.
The Technology Acceptance Model (TAM) adapts the original TRA to predict and explain a person’s adoption of information technology [5]. TAM identifies two relevant beliefs, that is, perceived ease of use and perceived usefulness. Perceived ease of use is defined as the extent to which an individual believes that using the system will be free of effort, while perceived usefulness is defined as the extent to which an individual believes that using the system will enhance the job performance. According to TAM, the usage of information technology is influenced by behavioral intention to use the information technology, while behavioral intention is determined jointly by perceived usefulness and attitude toward information technology usage. Furthermore, the attitude toward information technology usage is jointly determined by perceived ease of use and perceived usefulness. Perceived usefulness is also influenced by perceived ease of use and external variables. TAM has been widely applied in practice, extended in academics, and empirically tested in the field of information management in the last decade.

C. Patient Trust

By the reform of the NHI in Taiwan, the development of medical standards, and the increasing competition between hospitals, the patient-physician relationship is viewed as an important part of the medical care process, and patient-physician trust is the most important component of the relationship. Anderson and Dedrick [6] referred patient trust to a group of beliefs or expect that physicians will act in some certain ways. Caterinicchio [7] viewed patient trust as reliance on physicians. Dugan, Trachtenberg, and Hall [8] suggested that with trust in medical officials, patients will have confidence in any treatment. Shea and Effken [9] argued that patient-provider trust can ease the burden of health care. When patients are experiencing illness, disability, and/or recuperation, the ability to trust healthcare professionals reduces the stress of uncertainty.


Mayer, Davis, and Schoorman [13] suggested that trust comes from the ability, integrity, and benevolence of the one being trusted. McAllister [14] argued the components of trust are affect-based and cognition-based. Gremler and Gwinner [15] suggested that care and personal connection are two antecedents of trust. Mohseni and Lindstrom [16] argued that trust could be divided into vertical trust in the institutions of society (institutional trust), and horizontal trust or generalized trust in other people (social trust). The health-care system (such as hospitals) is an institution. Institutional trust allows patients to trust providers without any personal knowledge of the health workers [17]. Patient trust in health-care providers has been claimed to be associated with clinical or technical competence of the providers, the interpersonal quality of care (e.g. listening, respect), and the concern for the person, not just the disease [16]. Therefore, we also propose that both institutional trust and social trust are two dimensions of patient trust.

Telecare is a novel technology to both the patient and the care provider. Most patients experiencing new telecare services have little knowledge of the potential benefits, so they may perceive higher risk, resulting in a reduced disposition to trust the providers [9]. Sproull and Kiesler [18] also argued that in a networked environment, the focus of attention changes from the relationship between a person and technology to the relationship between a person and other people. Critics of telecare have often pointed out that video-mediated communication in health care may be impersonal and affect the therapeutic relationship [2]. Ma [19] also pointed out that assurance should play an important role in measuring reliability of online information system. Assurance refers to the ability the online system convey trust to their consumers. Liu, Yang, and Tan [20] also argued that economic action of individuals is influenced by the trust. Without the sense of trust, we cannot engage in the human exchange. Therefore, the development of a trustworthy relationship between patients and providers is very important during video-mediated interaction.

Some previous empirical studies supported integrating trust with the TAM model. Reid [21] integrated trust with the TAM model, arguing that trust relates to perceived ease of use and perceived usefulness. Gefen, Karahanna, and Straub [22] also proved that institutional trust has a positive impact on perceived ease of use and perceived usefulness. Pavlou [23] proposed the e-commerce acceptance model, and the findings also support the proposed hypotheses. Therefore, if the care provider or the institution (hospital) can be trusted to behave in accordance with patients’ confident beliefs, then patients should expect to gain the utility (perceived ease of use and perceived usefulness) from using the telecare system.

The previous arguments support the proposed research model depicted in Figure 1.
III. RESEARCH METHOD

We adopted the questionnaire survey for data collection, and examined our hypotheses by applying the structural equation modeling (SEM) method to validate the model. The measurement instruments for variables in the questionnaire were developed from previous studies to enhance the variability and reliability. Responses to the various variables related to the perceptions of the individual subjects were measured using the Likert-type scale.

The questionnaire items included demographic characteristics, perceived ease of use, perceived usefulness, and usage intention of using telecare systems. The survey subjects of the questionnaire were those residents who are the end users of a telecare system from Nantou County, Taiwan. These end users all used the telecare system for one month. The telecare system was developed and installed by a community hospital in Jhushang township, namely Chu Shang Show Chwan Hospital. The overall telecare system is shown in Figure 2.

IV. RESULTS

The data analysis proceeds according to the two-step approach recommended by Anderson and Gerbing [24]. First, we assess the measurement model, which consists of the seven latent factors, and includes the assessment of reliability, discriminant validity, and convergent validity of the scales. Second, we validate the structural model,
which represents the series of path relationships linking
the seven constructs.

A. Sample Characteristics

Of the recruited 370 subjects, there were 365 subjects who agreed to participate in the study. Of these respondents, 217 respondents are women (59.5%) and 148 respondents are men (40.5%). Most of the respondents were 71-80 years of age (41.9%). Most respondents hold elementary school degrees (46.8%). A majority of the caregivers are spouses (48.8%). The respondents mostly suffered from at least one chronic disease (71.2%). Table I presents descriptive statistics for the seven constructs in the study. The mean scores for seven constructs are all almost on the middle point of 5-point Likert-type scales, and show a reasonable dispersion in their distributions across the ranges.

| TABLE I |
| SAMPLE DEMOGRAPHICS |
| Construct | Mean | Standard Deviation | Minimum | Maximum |
| Social Trust | 4.70 | 0.578 | 1.00 | 5.00 |
| Institutional Trust | 4.48 | 0.685 | 2.00 | 5.00 |
| Perceived Ease of Use | 4.50 | 0.791 | 2.00 | 5.00 |
| Perceived Usefulness | 4.72 | 0.520 | 3.00 | 5.00 |
| Usage Intention | 4.59 | 0.697 | 2.00 | 5.00 |

B. Measurement Model Results

To validate the measurement model, three types of validity were assessed: content validity, convergent validity, and discriminant validity. Content validity was done by interviewing senior system users and pilot-testing the instrument. And the convergent validity was validated by examining Cronbach’s α, composite reliability and average variance extracted from the measures [25]. As shown in Table II, the Cronbach’s α of every subscale range from 0.958 to 0.994 was above the acceptability value 0.7 [26]. Moreover, the composite reliability values, which ranged from 0.958 to 0.994, and the average variances extracted by our measures, which ranged from 0.900 to 0.988, are all within the commonly accepted range greater than 0.5 [25]. In addition, all measures are significant on their path loadings at the level of 0.001. Therefore, the convergent validities of all seven constructs are confirmed.

| TABLE II |
| CONSTRUCT RELIABILITY AND CONVERGENT VALIDITY |
| Construct | Cronbach’s α | Composite Reliability | Average Variance Extracted |
| Social Trust | 0.992 | 0.992 | 0.977 |
| Institutional Trust | 0.962 | 0.964 | 0.900 |
| Perceived Ease of Use | 0.958 | 0.958 | 0.920 |
| Perceived Usefulness | 0.994 | 0.994 | 0.983 |
| Usage Intention | 0.994 | 0.994 | 0.988 |

In addition, according to Fornell and Larcker [27], discriminant validity can be tested among all constructs by comparing the average variance extracted (AVE) of each construct with the squared correlation of that construct and all the other constructs. All squared correlations between two constructs are less than the average variance extracted of both constructs. Therefore, the results confirm that the discriminant validity of the constructs in the study is satisfactory.

C. Structural Model Results

To validate the measurement model, we used AMOS 8.0 to assess the analysis. As shown in the Table III, the goodness-of-fit indices are within the accepted thresholds. Generally, these fit indexes are all greater than or equal to 0.9 for GFI, AGFI, NFI, and CFI. Furthermore, \( \chi^2 / \text{d.f.} \)
value is less than 5 and RMSEA value is less than 0.05. Accordingly, the summary of the overall goodness-of-fit indices indicate an excellent fit of the model and data.

TABLE III
FIT INDICES FOR THE STRUCTURAL MODEL

<table>
<thead>
<tr>
<th>Structural Model Statistic</th>
<th>Fit Indexes</th>
<th>Recommended Threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\chi^2$</td>
<td>127.321</td>
<td>-</td>
</tr>
<tr>
<td>$\chi^2$/d.f.</td>
<td>2.234</td>
<td>&lt; 5</td>
</tr>
<tr>
<td>GFI</td>
<td>0.949</td>
<td>&gt; 0.9</td>
</tr>
<tr>
<td>RMSEA</td>
<td>0.05</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>AGFI</td>
<td>0.919</td>
<td>&gt; 0.9</td>
</tr>
<tr>
<td>NFI</td>
<td>0.986</td>
<td>&gt; 0.9</td>
</tr>
<tr>
<td>RFI</td>
<td>0.981</td>
<td>&gt; 0.9</td>
</tr>
<tr>
<td>IFI</td>
<td>0.992</td>
<td>&gt; 0.9</td>
</tr>
<tr>
<td>TLI</td>
<td>0.990</td>
<td>&gt; 0.9</td>
</tr>
<tr>
<td>CFI</td>
<td>0.992</td>
<td>&gt; 0.9</td>
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</table>

Figure 3 illustrates the results of the structural model with the estimated standardized path coefficients and path significance among constructs. As predicted, all proposed hypotheses are supported. The estimated standardized path coefficients indicate the strengths of the relationships between the dependent and independent variable. As expected, both social trust ($\beta=0.279$) and institutional trust ($\beta=0.151$) have significant effects on perceived ease of use. Social trust ($\beta=0.132$), institutional trust ($\beta=0.183$), and perceived ease of use ($\beta=0.412$) have all significant effects on perceived usefulness. In addition, both perceived ease of use ($\beta=0.212$) and perceived usefulness ($\beta=0.462$) have significant effects on usage intention.

The results of the structural model show that patient trust (social trust and institutional trust), perceived ease of use, and perceived usefulness are key aspects affecting usage intention of telecare system. The results also demonstrate that patient trust (social trust and institutional trust) have significant impacts on usage intention mediated by perceived ease of use, and perceived usefulness.

Figure 3 Final Proposed Model

V. CONCLUSIONS

Based on the TAM model, this study proposed a research model to better understand the older residents’ usage intention of telecare system. The model considered the relationships among social trust, institutional trust, perceived ease of use, perceived usefulness, and intention.
to use. Using Structural Equation Modeling (SEM), the hypotheses are proposed to validate the fit of empirical data and model. The results show that the relationships proposed in the model are all supported. Our findings suggest that both perceived ease of use and perceived usefulness are two important antecedents that directly influence behavioral intention to use the telecare system. In addition, both social trust and institutional trust have significantly positive effects on perceived ease of use, and perceived usefulness separately. Furthermore, both social trust and institutional trust have significant impacts on usage intention mediated by perceived ease of use, and perceived usefulness.

With an aging population, the care of older people and the role of the telecare system will become increasingly important [28]. Both perceived ease of use and perceived usefulness are crucial determinants to predict intention to use the telecare system. Accordingly, the perceptions and experiences of the elderly (or patients) about telecare will influence their degree of acceptance. This implies that the managers of hospitals and designers of telecare system companies should pay more attention to understanding the perceptions of the elderly (or patients) and improving the system quality of the system. Not only the operating functions of the telecare system need to be as easy as possible to use, but also the output information of the telecare system needs to be developed to be beneficial for individuals’ levels of health status.

This study also confirms that both social trust and institutional trust are important antecedents of perceived ease of use, and perceived usefulness. Social trust means being comforting, empathy, humanistic caring, and respecting patients’ opinion and feeling. Thom [29] also found willingness to refer and respect for feelings, opinions, and self-knowledge were the most important behaviors, especially for younger patients. Therefore, it is very important to cultivate equality and a partnership in the doctor-patient’s relationship. Institutional trust may influence individual trust, especially in newly formed relationships [11]. The healthcare industry is customer oriented by nature because a large proportion of employees in healthcare organizations are health service providers, such as physicians, nurses, pharmacists, radiologist, physical therapists, and so on. Many studies have shown that when healthcare providers are more relationship-centered, patients are likely to express higher satisfaction [30]. The executives and managers of hospital should encourage and support the patient-centered or relationship-centered climate.

The integrative viewpoint implies that a successful telecare system is not only an information system but also but also a service provider/department to the patients. We believe this study is a useful starting point to explore the implementation of telecare systems in Taiwan. Future research could continue to explore the other factors that influence adoption decisions in the telecare system.

REFERENCES


Chung-hung Tsai is associate professor and dean of academic affairs at Tzu Chi College of Technology. He received his Ph. D. degree from National Dong-Hwa University. He is currently one member of the editorial board and reviewer of Journal of Healthcare Management.