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Information & Management 39 (2002) 297–311

INFORMATION & MANAGEMENT

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Investigating healthcare professionals' decisions to accept telemedicine technology: an empirical test of competing theories

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Received 7 September 2000; accepted 14 April 2001

Abstract

The proliferation of information technology (IT) in supporting highly specialized tasks and services has made it increasingly important to understand the factors essential to technology acceptance by individuals. In a typical professional setting, the essential characteristics of user, technology, and context may differ considerably from those in ordinary business settings. This study examined physicians' acceptance of telemedicine technology. Following a theory comparison approach, it evaluated the extent to which prevailing intention-based models, including the technology acceptance model (TAM), the theory of planned behavior (TPB) and an integrated model, could explain individual physicians' technology acceptance decisions. Based on responses from more than 400 physicians, both models were evaluated in terms of overall fit, explanatory power, and their causal links. Overall, findings suggest that TAM may be more appropriate than TPB for examining technology acceptance by individual professionals and that the integrated model, although more fully depicting physicians' technology acceptance, may not provide significant additional explanatory power. Also, instruments developed and repeatedly tested in prior studies involving conventional end-users and business managers may not be valid in professional settings. Several interesting implications are also discussed.

Keywords: IT acceptance and adoption; Telemedicine; Technology management; Structural equation models; Professional users

1. Introduction

Recent information technology (IT) developments have expanded into areas that can be broadly characterized by their technology applications and targeted users. To excel, or even survive, most businesses continue to rely on, and indeed accelerate, heavy investment in IT. Concurrently, various IT applications designed to support highly specialized tasks and services by individual professionals have also proliferated. A case in point is telemedicine technology for healthcare professionals. Understandably, physicians are among the principal users of this technology and have profound influences on its success. Physicians may exhibit interesting or fundamental differences from ordinary business user groups, in part because of their professional training, etc.

Most telemedicine research has focused on the technology developments and clinical applications

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0378-7206/02/$ – see front matter
PII: S0378-7206(01)00098-2

essential to its success. Consequently, there has been limited discussion of managerial issues that are arguably equally important. This study investigated user technology acceptance in healthcare organizations already providing or planning to provide telemedicine-enabled patient care and services. Thus, examining the validity and explanatory (or predictive) utility of prevalent theories or models in a professional setting is particularly interesting and timely.

Specifically, this study examined and compared the technology acceptance model (TAM) [14,15] and the theory of planned behavior (TPB) [1,2]. Both TAM and TPB are leading theoretical models for such research and have accumulated fairly strong empirical support involving various end-users and business managers. We also examined a model integrating elements derived from both TAM and TPB. In a nutshell, theory testing follows replication logic and hence makes theory comparison an attractive approach, i.e. generating support for a theory (or some theories) and, at the same time, singling out the potential limitations of others. Using the responses from a survey study that involved more than 400 physicians, the research effort evaluated and compared the extent to which the respective models could explain individual physicians' intention to use telemedicine technology. The causal paths specified by each model were also examined.

2. Telemedicine and its technology adoption

Recent advances in telemedicine technology are an important form of IT-enabled delivery and decision support for healthcare professionals. Persistent problems plaguing contemporary health care, including access, quality, resource distribution, and cost containment, have contributed to telemedicine's economic, social, and political appeal. A fast-growing number of telemedicine programs have been established (or are under way) around the world [21]. In a fairly comprehensive review of telemedicine and its clinical applications, Perednia and Allen [34] suggest that the ultimate success of telemedicine requires that an adopting organization address not only technological but also managerial challenges, including user technology acceptance. Payton [33], in her study of three inter-organizational health care information systems (IS), also concludes "physicians clearly played the most significant role in the implementation process" (p. 315). Given the potential impact of telemedicine technology, it is therefore important to investigate factors essential to its acceptance by individual physicians.

Compared with end-users and business managers commonly studied in prior research, physicians may make technology acceptance decisions differently. For instance, many physicians are not particularly technology literate, in spite of their general competence and learning capacity. Having experienced highly demanding educational and specialized training, physicians are experts in their own profession and accustomed to practice in a particular way or style similar to that in which they were trained. Findings from prior studies suggest that physicians are reluctant to give a positive response to implementation of an IS that interferes with their traditional routines [4,5]. In addition, physicians usually practice with relatively high autonomy.

Several previous studies have examined physician acceptance of telemedicine technology [3,18,26,27, 30]. However, most of them were limited in scope and scale and, more importantly, tested hypotheses that lacked adequate theoretical foundations. Examinations of user technology acceptance have been fairly abundant, particularly involving conventional end-users and business managers. TAM and TPB have emerged as two dominant models and together provide a theoretical foundation upon which an integrated model was developed and examined.

3. Research scope and investigated models

In this paper, telemedicine refers to the use of IT to support healthcare services and activities via electronic transmission of information or expertise among geographically dispersed parties, including physicians and patients, in order to improve service effectiveness and resource allocation/utilization efficiency [7]. Technology acceptance is defined as "an individual's psychological state with regard to his or her voluntary or intended use of a particular technology" [17]. Collectively, findings from most prior research suggest that an individual's intention to use a technology can sufficiently approximate or measure his or her

actual use. Choice of intention as the measure (or surrogate) for it was theoretically justifiable and pragmatically adequate, considering that the implementation of telemedicine technology is at the early stage in Hong Kong, where interest has grown but usage is not yet widespread.

Abundant empirical evidence has suggested a sufficiently strong causal link between intention and behavior [36]. From a research perspective, Mathieson [28] justified and defended the use of behavioral intention as a dependent variable. From a technology management perspective, use of the established intention–behavior approach is appealingly timely, allowing examination of physicians' technology acceptance at a time when a fast-growing number of healthcare organizations are implementing or contemplating the adoption of telemedicine technology.

Behavioral intention has been shown to explain or predict an individual's performing a conscious act, such as deciding to accept (or use) a technology. The investigative locus, then, is on identifying essential intention determinants that conceivably may include attitude, social influences, and other facilitating factors. The theory of reasoned action (TRA) [16] is a well-established intention-based theory. According to it, beliefs influence attitude, which in turn shapes intention that subsequently guides or dictates behavior. Innovation diffusion theory (IDT) represents another approach to user technology acceptance. An important conceptual difference between IDT and TRA is that the former concentrates on the characteristics intrinsic to a technology (or innovation) whilst the latter anchors its analysis at how important characteristics of a technology are communicated and perceived by target users. Derived from TRA, both TAM and TPB follow the common thread of belief–intention–behavior and have been applied extensively to examining user acceptance of a wide array of information technologies. Partially because of its choice of technology acceptance measure, our effort followed the intention-based approach and aimed at examining and comparing TAM and TPB and an integrated model derived from them.

TAM was examined without including its last construct (i.e. actual behavior). As depicted in Fig. 1, behavioral intention is determined jointly by attitude and perceived usefulness, the latter of which also influences attitude directly. Meanwhile, perceived ease of use directly affects both attitude and perceived usefulness. In our context, TAM suggests that a physicians' perception of the degree to which telemedicine technology is easy to use affects both perception of usefulness and attitude toward using the technology. Attitude is also influenced by its usefulness, as perceived by a physician. Ultimately, the physicians' intention to use telemedicine technology can be explained or predicted by the attitude (towards using the technology) and its perceived usefulness.

TPB was the second model investigated, also without its last construct (i.e. actual behavior). As shown in Fig. 2, it states that behavioral intention is jointly determined or predicted by three factors: attitude, subjective norms, and perceived behavioral control. In our context, TPB states that a physicians' intention to use telemedicine technology is simultaneously determined by such factors as positive or negative evaluative affect about using the technology, perception of others opinions on whether or not to use technology, and perception of the availability of skills, resources and opportunities necessary for using it.

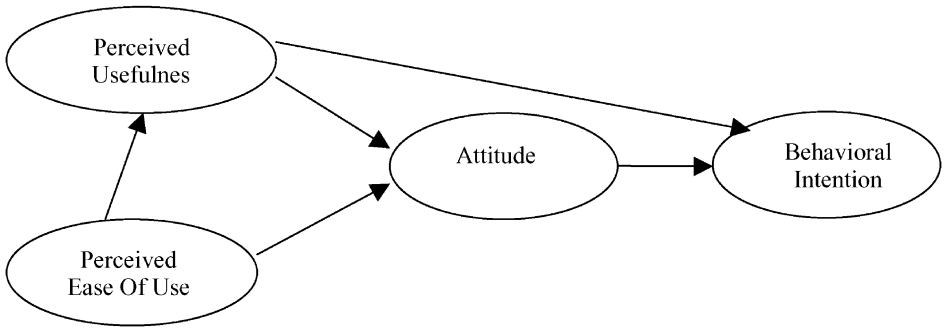

Fig. 1. Model 1: TAM.

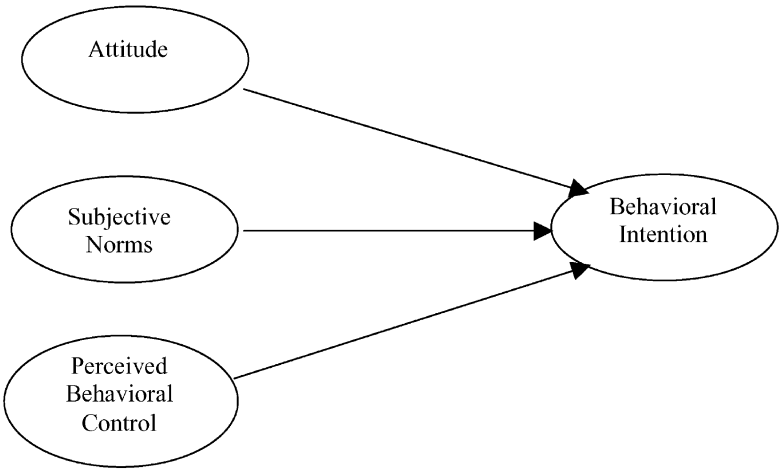

Fig. 2. Model 2: TPB.

An integrated model derived from TAM and TPB was then examined, as shown in Fig. 3. The rationale is that both TAM and TPB are extended from TRA but have different foci, making their integration theoretically compatible and potentially complementary. Hence, the cognitive influences specified by TAM may serve as important precedents of attitudinal beliefs in TPB, which reciprocally may enhance the explanatory power of TAM via its potential for adding dimensions essential to individual technology acceptance. The integration was examined by Taylor and Todd [40], who investigated the role of experience in individual IT usage. Thus, the intensity of a physicians' intention to use telemedicine is determined by three factors: attitude, subjective norms, and perceived behavioral control, as suggested by TPB. Furthermore, attitude is determined by both perceived usefulness and perceived ease of use. The underlying causal

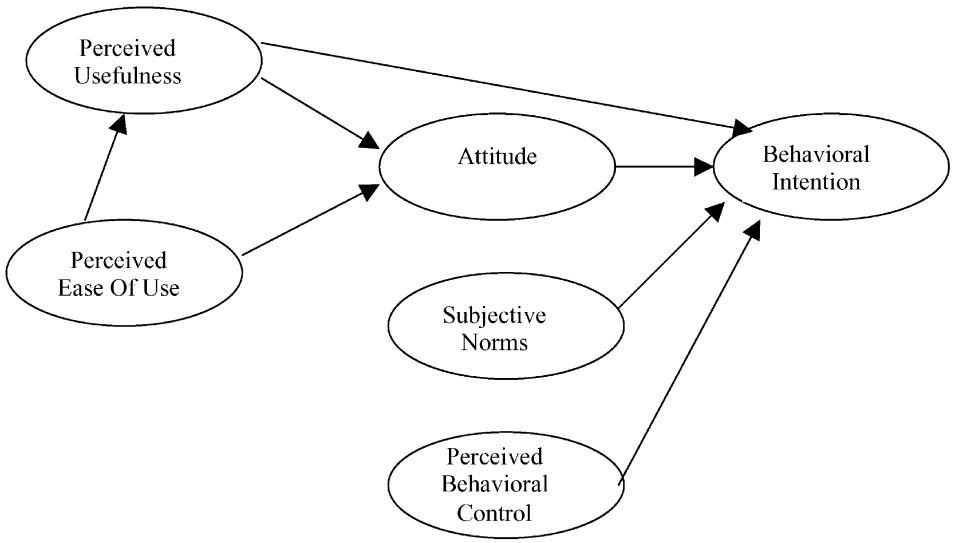

Fig. 3. Model 3: Integrated.

relationships among attitude, perceived usefulness and perceived ease of use follow those specified by TAM.

4. Research method and design

4.1. Measures

Items used to operationalize the constructs included in each investigated model were mostly adopted from relevant prior research, with necessary validation and wording changes tailored to telemedicine and the targeted professional context. Specifically, items measuring perceived usefulness and perceived ease of use were adapted from Davis [14], whereas items for subjective norms, perceived behavioral control and attitude were obtained from Taylor and Todd [39]. Similarly, measurements of behavioral intention were derived from both. In addition, constructs shared by different investigated models were measured using the same items.

All items were measured using a seven-point Likert-type scale with anchors from ''strongly agree'' to ''strongly disagree''. To ensure desired balance and randomness in the questionnaire, half of the items were worded with proper negation and all items were randomly sequenced on the questionnaire in order to reduce the potential ceiling (or floor) effect that induces monotonous responses to the items designed to measure a particular construct.

4.2. Pre-tests

Although validated by prior research, the adopted instrument was examined to ensure content validity and reliability within the targeted context. Instrument validation or re-validation is necessary because its validity may not be persistent across different technologies and user groups [37]. First, three physicians from different medical specialty/subspecialty areas were asked to assess content validity. Using a card sorting method suggested by Moore and Benbasat [31], all question items in the instrument were printed on 8 cm × 6 cm index cards, which were shuffled randomly and then presented to the physicians individually. Each was asked to sort the cards into appropriate categories that represented the respective constructs. Results from the card sorting pre-test were satisfactory, showing an accuracy rate of 90% or higher for each physician. Using the same physicians, the instrument was then evaluated for wording clarity and question item sequence adequacy.

Using responses to the questionnaire from a pre-test group of another 35 physicians, the instrument's reliability was evaluated. The resultant Cronbach's α values (ranging from 0.62 to 0.85) indicated a satisfactory reliability level, exceeding that commonly required for exploratory research [32]. Comments and suggestions on question item sequence and wording choices were also solicited; this led to several minor modifications to the instrument. The final items are listed in the Table 1, together with their sources. Subjects who had participated in the pre-tests were excluded from the subsequent study.

4.3. Study administration

The study targeted physicians who practiced at public acute-care tertiary hospitals in Hong Kong[1]. Together, the physicians represented ten medical specialty or subspecialty areas. Choice of the target physicians was made primarily because of their present or probable future involvement in telemedicine technology. As a group, physicians at public acute-care tertiary hospitals in Hong Kong have considerable inter-organizational service needs that might be supported by telemedicine technology. Common service needs include provision of second or specialist's opinions, evaluation of patient transfer or admission requests, participation in cross-organizational, team-based collaborative patient management, and providing urgent care in medical emergencies [24,25]. At the time of the study, all established telemedicine programs in Hong Kong involved public tertiary hospitals, which collectively provide more than 90% of the tertiary care. The decision on the particular medical specialty/subspecialty areas to be included was primarily based on their frequent inclusion by prior telemedicine research and documented clinical application results. These areas were internal medicine, geriatrics, pediatrics, obstetrics

[1] Each tertiary hospital serves as the integral of a clinical cluster defined by the Hospital Authority and is charted to provide patients and primary/secondary care providers in the cluster with the necessary services in various medical speciality and subspecialty areas.

Table 1
Question items used in the study

Construct	Item	Measure	Source
Attitude (ATT)	ATT1	Using telemedicine technology in patient care and management is a good idea	[39,40]
	ATT2	Using telemedicine technology in patient care and management is unpleasant	
	ATT3	Using telemedicine technology is beneficial to my patient care and management	
Subjective norms (SN)	SN1	People who influence my clinical behavior think that I should use telemedicine technology	[39,40]
	SN2	People who are important to my health care services think that I should not use telemedicine technology	
	SN3	People who are important in assessing my patient care and management think that I should not use telemedicine technology	
Perceived behavioral control (PBC)	PBC1	I would have the ability to use telemedicine technology in my patient care and management	[39,40]
	PBC2	Using telemedicine technology would be entirely within my control	
	PBC3	I would not have the knowledge to make use of telemedicine technology in my patient care and management	
	PBC4	I would have the resources (including training) to make use of telemedicine technology in my patient care and management	
Perceived usefulness (PU)	PU1	Using telemedicine technology cannot improve my patient care and management	[14]
	PU2	Using telemedicine technology cannot enhance my effectiveness in patient care and management	
	PU3	Using telemedicine technology can make my patient care and management easier	
	PU4	I would find telemedicine technology not useful for my patient care and management	
Perceived ease of use (PEOU)	PEOU1	Learning to operate telemedicine technology would not be easy for me	[14]
	PEOU2	I would find it easy to get telemedicine technology to do what I need it to do in my patient care and management	
	PEOU3	It is not easy for me to become skillful in using telemedicine technology	
	PEOU4	I find telemedicine technology easy to use	
Behavioral intention (BI)	BI1	I intend to use telemedicine technology for patient care as often as needed	[14,39,40]
	BI2	Whenever possible, I intend not to use telemedicine technology for patient care	
	BI3	To the extent possible, I would use telemedicine technology in my patient care frequently	

and gynecology, surgery, emergency care, intensive care, psychiatry, pathology, and radiology.

A total of 70 clinical departments at eight public acute-care tertiary hospitals were contacted; 41 of them agreed to take part in the study, showing a 59% participation rate. The chief of service of each department assisted the distribution of questionnaire packets to physicians in the department. Each packet contained a cover letter that described the study's purpose, intended use and management of data, two endorsement letters (from the Hong Kong Telemedicine Association and the Hospital Authority), the questionnaire, and selected telemedicine technology references appropriate for the target medical areas. Immediately after the questionnaire distribution, a letter soliciting internal promotion of the study was faxed to the chiefs of service of all participating departments. Physicians were asked to complete the

questionnaires individually and return them to designated department secretaries, from whom the questionnaires were collected.

Of the 1728 questionnaires distributed, 421 were returned. We excluded 13 partially completed responses from subsequent analysis. Thus, the effective responses numbered 408, showing a 23.6% effective response rate. Among the respondents, 75% were male and approximately 80% had received their medical education in Hong Kong. On average, the responding physicians were 35 years old and had 9.4 years of post-internship clinical experience in their specialty or subspecialty areas.

5. Data analysis results

5.1. Reliability and validity of research constructs

The factors (i.e. constructs) specified in each investigated model were evaluated in terms of reliability, convergent validity, and discriminant validity. Reliability was examined using the Cronbach's α values. As summarized in Table 2, most of these, except for perceived behavioral control, were above or close to 0.70; this represents a commonly acceptable level for exploratory research. Although validated by Taylor and Todd, the scale of perceived behavioral control exhibited a reliability value of 0.55, lower than that commonly required.

Factor analysis was then conducted to examine measurement convergent and discriminant validity. Specifically, an iterated principal axis analysis with a promax rotation was performed, primarily because of the probable correlation between or among the factors examined [19,23]. Typically, convergent validity is considered to be satisfactory when items load high on their respective constructs (i.e. factors). As depicted in Table 3, results showed that six factors were extracted with an eigenvalue >1.0 and that all items loaded high on the expected constructs. Most items exhibited loading higher than 0.50 on their respective factors, signifying desirable measurement convergent validity. The only exception was perceived behavioral control, whose loading was slightly below 0.50 (but higher than 0.40). Discriminant validity was evaluated by examining whether each item loaded higher on the construct it measured than on any other.

Table 2
Summary of measurement scales

Construct	Mean	S.D.	Reliability
Attitude (ATT)			
ATT1	2.83	1.03	0.69
ATT2	2.96	1.16	
ATT3	2.59	1.15	
Subjective norms (SN)			
SN1	3.66	1.07	0.75
SN2	3.30	1.03	
SN3	3.36	1.07	
Perceived behavioral control (PBC)			
PBC1	2.85	1.08	0.55
PBC2	3.94	1.34	
PBC3	2.88	1.39	
PBC4	3.85	1.31	
Perceived usefulness (PU)			
PU1	2.80	1.17	0.86
PU2	3.04	1.20	
PU3	3.30	1.22	
PU4	2.93	1.16	
Perceived ease of use (PEOU)			
PEOU1	3.02	1.30	0.77
PEOU2	3.46	1.16	
PEOU3	3.11	1.60	
PEOU4	3.21	1.18	
Behavioral intention (BI)			
BI1	3.47	1.28	0.86
BI2	2.98	1.26	
BI3	3.23	1.26	

As summarized in Table 3, the overall results suggested that the measurement exhibited reasonable discriminant validity.

5.2. Model testing results

Each model was tested using LISREL [6]. Using sample covariance matrices, the overall fit and the predictive power of each model were examined, together with the relative strengths of the individual causal paths each model specified.

Six common model goodness-of-fit measures were examined: Chi-square/d.f.; goodness-of-fit index (GFI); adjusted goodness-of-fit index (AGFI); non-norm fit index (NNFI); comparative fit index (CFI) and standardized root mean square residual (SRMSR). The Chi-square statistic was not used because of its

Table 3
Results of factor analyses[a]

Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
PU1	0.87					
PU2	0.82					
PU4	0.80					
PU3	0.64					
PEOU4		0.77				
PEOU1		0.75				
PEOU3		0.66				
PEOU2		0.53				
SN3			0.90			
SN2			0.77			
SN1			0.50			
BI3				0.80		
BI1				0.77		
BI2				0.63		
ATT1					0.79	
ATT2					0.61	
ATT3					0.57	
PBC1						0.61
PBC4						0.46
PBC3						0.46
PBC2						0.43
Eigenvalue	3.34	2.36	2.09	1.92	1.57	1.33
% of variance	13.90	9.85	8.70	8.00	6.56	5.55

[a] Only loadings with 0.40 or above are shown.

inherent problems with or sensitivity to sample size [9,20]. As shown in Table 4, all the indices exceeded their respective common acceptance levels [12], suggesting that each model provided a reasonably good fit to the data. However, no statistical differences were found in any included model goodness-of-fit measures, suggesting that all the investigated models were of comparable fit.

Table 4
Overall fits of models

Fit index	Recommended value	TAM	TPB	Integrated
Chi-square/d.f.	$\leq$3.0	2.11	1.74	2.42
GFI	$\geq$0.90	0.95	0.96	0.92
AGFI	$\geq$0.80	0.92	0.94	0.90
NNFI	$\geq$0.90	0.95	0.95	0.93
CFI	$\geq$0.90	0.96	0.96	0.94
SRMSR	$\leq$0.10	0.04	0.04	0.04

The explanatory power of each model was also examined, as summarized in Figs. 4–6. The overall results suggested that TAM appeared to be better than TPB here, as suggested by a R^2_{BI} of 0.42 for TAM and a R^2_{BI} of 0.37 for TPB. The improved explanatory utilities anticipated from the integrated model were neither significant nor noticeable, as manifested by a marginal improvement of R^2_{BI} from 0.42 (by TAM) to 0.43. The attitude and perceived usefulness variances accounted by TAM were identical to those by the integrated model. Together, perceived usefulness and perceived ease of use accounted for 36% of the observed variance in attitude (i.e. $R^2_{ATT} = 0.36$). However, perceived ease of use explained only 1% of the variance in perceived usefulness (i.e. $R^2_{PU} = 0.01$).

The significance of individual paths was examined and also summarized in Figs. 4–6. Two observations are worth discussing. First, the significance or lack of significance of a path was consistent across different

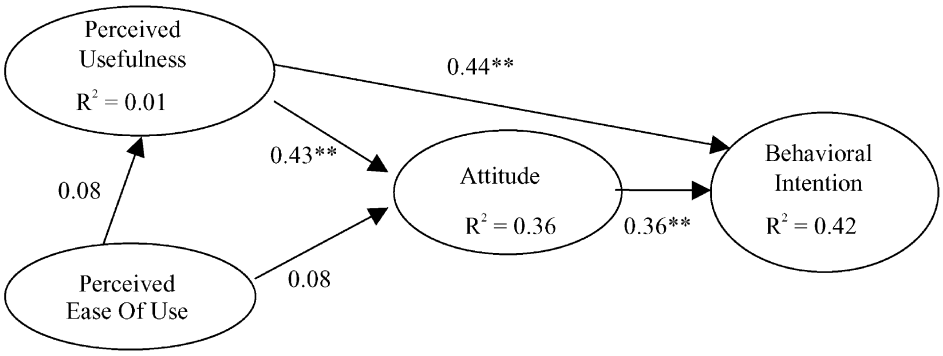

Fig. 4. Results of Model 1: TAM.

(competing) models that specified that path. Second, all the significant paths were of considerably high-significance levels. Specifically, seven out of the nine paths exhibited a *P*-value of <0.001, whereas the remaining two had a *P*-value of <0.01.

The path from attitude to behavioral intention was significant across all the investigated models. Perceived usefulness appeared to be a significant determinant of attitude and behavioral intention in both TAM and the integrated model, whereas perceived ease of use seemed to have insignificant influence in both models. In addition, the path from perceived behavioral control to intention was significant in the TPB and the integrated model. However, the path from subjective norms to behavioral intention was not significant in either.

The strength of an individual path was evaluated using the standardized path coefficient, ranging from −1 to +1. The total effect of one factor on another is obtained by summing up its direct and indirect effects

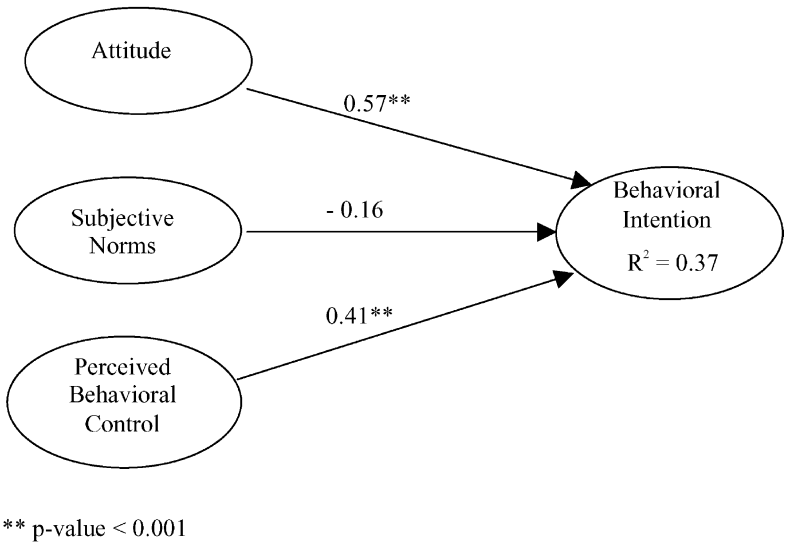

Fig. 5. Results of Model 2: TPB.

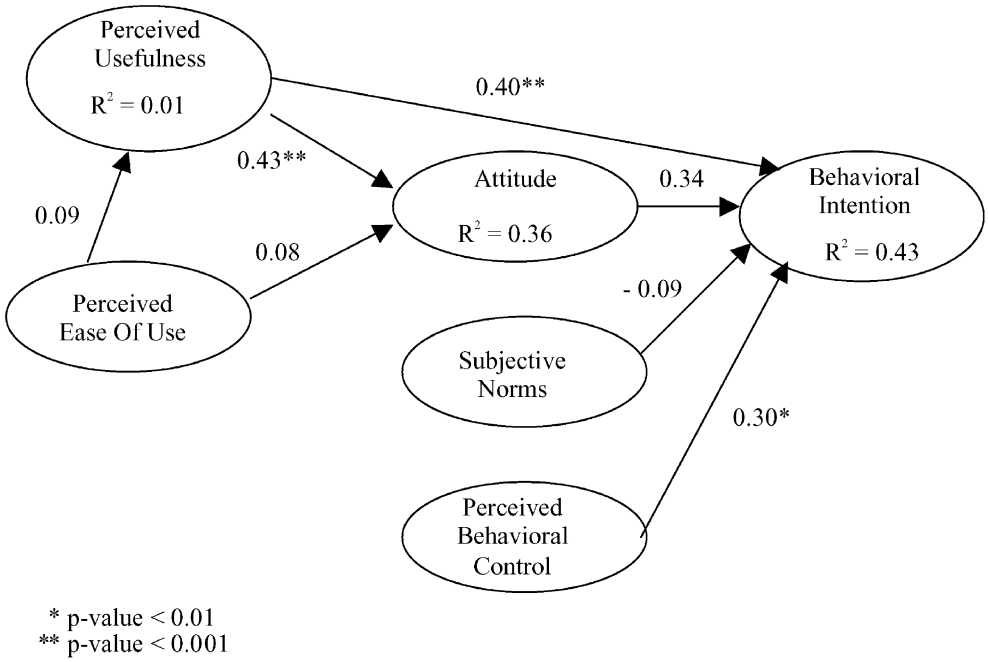

Fig. 6. Results of Model 3: Integrated.

via relevant intervening factors. Bollen [8] strongly advocates the importance not only of the direct effects but also of the indirect and the total effects when interpreting results in a structural equation model. Table 5 summarizes the relative strength of each path specified by the respective models. As shown, perceived usefulness exhibited the strongest direct, indirect and total effects on behavioral intention, across all the investigated models. Attitude appeared to have a weaker direct effect on behavioral intention than perceived usefulness but exhibited a stronger influence on behavioral intention than perceived behavioral control.

Table 5
Strengths of individual factors

Effect on behavioral intention	TAM	TPB	Integrated
Direct effect			
PU	0.44	–	0.40
ATT	0.36	0.57	0.34
SN	–	n.s.	n.s.
PBC	–	0.41	0.30
Indirect effect			
PU	0.15	–	0.15
PEOU	n.s.	–	n.s.
Total effect			
PU	0.59		0.55
PEOU	n.s.	–	n.s.
ATT	0.36	–	0.34
SN	–	0.57	n.s.
PBC	–	n.s.	0.30

6. Discussion

Several implications can be readily obtained from the study results.

Perceived usefulness appeared to be the most significant factor affecting physicians' acceptance of telemedicine technology. The path coefficients from perceived usefulness to both attitude and behavioral intention were consistently the highest in all the models examined. Judging by the observed strong direct and indirect effect (via attitude) on behavioral intention, perceived usefulness is likely to insert great influences on a physicians' intention to use telemedicine technology. This finding has several implications. First, physicians apparently tended to be pragmatic in

their technology acceptance decisions, appearing to focus on usefulness in technology assessment. That is, a physician is likely to accept (or use) a technology when it is considered to be useful to his or her practice. Second, perceived usefulness was a critical determinant of attitude, exhibiting tremendous influences on individual attitude formation. This finding is consistent with the results from many prior studies that examined TAM. As Keil et al. [22] concluded, in determining whether or not to use a technology, usefulness is more important than ease of use. In our context, an essential factor for a physicians' acceptance of telemedicine technology is whether the technology fills his or her service needs. The observed significant role of perceived usefulness in individual attitude formulation might also have been partially rooted in physicians' tool-oriented view of technology, acceptable only when demonstrating proven or desired utility in their practices.

Perceived ease of use appeared to have no significant effects on either perceived usefulness or attitude. This is inconsistent with the results of some prior studies (e.g. [10,11]). The inconsistency is worth noting, because it might signify fundamental differences between individual professionals and the typical technology users commonly examined in previous research. By and large, physicians have relatively high general competence and mental/cognitive capacity and may comprehend the use of a technology quickly; that is, become familiar with its operations without going through the intense training that might be necessary among other user populations. Furthermore, physicians in many cases have relatively strong staff support for operating medical equipment and related technologies. Together, these factors might have contributed to physicians' placing less weight on perceived ease of use. As Keil et al. [22] commented, ''no amount of EOU (ease of use) will compensate for low usefulness''. In this connection, the explanatory power of TAM might weaken in a professional context characterized by high user competency or strong staff support.

Attitude appeared to be the second most important determinant of a physicians' intention for accepting telemedicine technology. This highlights the critical role of attitude in technology acceptance decision-making by individual professionals and therefore singles out the importance of attitude cultivation and management to successful technology implementation.

Subjective norms appeared to have no significant effects on behavioral intention. Physicians are likely to develop independent evaluations and consequently may place less weight on others' opinions. In turn, the finding that highlights the insignificance of perceived ease of use suggests another interesting dimension on which technology acceptance decisions might differ between individual professionals and other user populations.

Perceived behavioral control appeared to have significant influence on behavioral intention but not to an extent comparable to attitude. A plausible explanation for the significant but modest effect is that the operations of telemedicine technology in general may not be particularly complicated, especially when considering physicians' general competence, learning capability, and the staff support commonly available from nurses and technologists. Furthermore, the path from perceived behavioral control to behavioral intention was also less significant than that from perceived usefulness to behavioral intention. The observed weaker link between perceived behavioral control and behavioral intention might partially have resulted from physicians' limited experience with telemedicine technology.

Overall, findings from the study suggest TAM to be an appropriate model for explaining individual physicians' technology acceptance decisions. The model provides a parsimonious conceptual depiction of their technology acceptance decision-making with a reasonably strong empirical support, as measured by the analysis results from the study. Judged by explanatory power and path coefficients, TPB appears to be a weaker theory than TAM. The additional explanatory power generated by the integrated model appears to be marginal at best.

7. Conclusions

This study investigated factors essential to acceptance of telemedicine technology by individual healthcare professionals. We took a theory-comparison approach and used behavioral intention as a measure of technology acceptance. Findings of the study suggest several potential areas where healthcare

professionals might interestingly or fundamentally differ in technology acceptance decision-making, compared with the user populations commonly examined in prior research. First, when making a decision to accept versus reject a technology, healthcare professionals appear to be fairly pragmatic, concentrating on the technology's usefulness rather than on its ease of use. Furthermore, these professionals seem to be relatively independent in making technology acceptance decisions, e.g. not attaching much weight to suggestions or opinions from others. The study has the merits of evaluating individual technology acceptance in a real-world professional setting, including principal target users who assess telemedicine technology in light of their routine clinical tasks and services. In addition, this study represents a needed and timely effort for extending technology acceptance research into health care, a service sector that has demonstrated increasing IT investment and penetration [35].

This study has several limitations. First, this study concentrated on a particular technology and involved a specific professional group. Thus, caution needs to be taken when generalizing the findings and discussion to other technologies or professional groups. Second, measurement items for the constructs specified by the investigated models exhibited reasonable but not highly satisfactory reliability. Third, responses on behavioral intention were collected using a self-reporting method, a common data collection technique that has been justified and advocated by some researchers [29] but questioned for inadequacy or lack of validity by others [13]. Szajna [38] suggests that alternative behavior-oriented measures (e.g. choice behavior) should be used instead. Similarly, Thompson et al. [41] suggest the use of both objective and subjective measures that allow desired examinations of the correspondence (or the lack of it) between them, regardless of the dependent variable.

Despite its limitations, results from the study have some interesting implications. First, the study generates interesting empirical evidence that highlights plausible limitations of TAM and TPB in explaining or predicting technology acceptance by healthcare and possibly other professionals. Both models were able to account for an acceptable but not a dominant portion of the behavioral intention variances observed. The explanatory utility improvement for behavioral intention resulting from the addition of subjective norms and perceived behavioral control to TAM was limited, if any. The fact that none of the investigated models was able to explain half of the behavioral intention variance may signify the need for a broader exploration of factors beyond TAM and TPB. Responding to calls for additional theory-testing efforts to validate or extend the research results from prior studies, this study empirically investigated telemedicine technology acceptance by physicians.

Results from prior research may represent a logical and reasonable point of departure in searching for additional or mediating factors. Candidate factors might include self-efficacy, user participation and involvement, prior usage and experience, and user characteristics. Theory refinement through model decomposition represents a promising approach. Although a decomposed model may provide additional insights to behavioral intention and actual behavior, it does not guarantee significantly improved explanatory or predictive power. Theory expansion through model integration is another interesting approach. Collectively, the approaches and prior research may provide a reasonable starting point for identifying additional or mediating factors or developing theoretical frameworks instrumental to advancing our understanding of technology acceptance by individual professionals.

7.1. Implications for technology management practice

From a technology management standpoint, findings of the study reveal the importance of attitude cultivation and management. To foster individual acceptance of a newly adopted or implemented technology, management in a professional organization needs to devise strategies for cultivating positive attitudes toward using the technology. In this connection, favorable perception of the technology's usefulness is crucial, whereas the technology's ease of use might not be of equal importance. Upon deciding to adopt telemedicine technology, management should strongly emphasize, demonstrate and communicate the technology's usefulness to the routine tasks and services of individual physicians. Thus, initial information sessions and training programs should focus on how the technology can improve the efficiency or effectiveness of individual physicians'

patient care and services rather than on familiarization with the detailed procedures for operating the technology.

The observed insignificant effects of subjective norms on intention suggests that a physician, when making the technology acceptance decision, might value his or her own assessments more than the opinions and suggestions of others. This finding may have in part resulted from the overall early development of telemedicine in Hong Kong, where the number of telemedicine ''guru'' or highly experienced physicians is limited. Awareness and understanding of successful telemedicine programs and applications elsewhere may mitigate this constraint. By witnessing and interacting with peers known for telemedicine-enabled services, physicians may be able to assess the technology from a different and perhaps broader perspective. Continued education programs, clinical workshops and international conferences are adequate arrangements for increased awareness and knowledge about telemedicine technology and its applications.

The modest significance of perceived behavioral control on intention, though weaker than that of attitude, suggests that perceived behavioral control remains important in shaping individual intention toward technology acceptance. The observed weaker influence, as compared to that of attitude, may have in part attributed to the characteristics of public acute-care tertiary hospitals in Hong Kong. By and large, these organizations have a fairly sophisticated in-house technology base and reasonable access to various resources, including designated space to house telemedicine technology. Thus, convenient technology access and in-house technology training and support are usually available and consequently may not constitute central concerns in physicians' technology acceptance decisions. When introducing telemedicine technology and promoting its acceptance among physicians, management, nevertheless, needs to evaluate these facilitating conditions, e.g. access and training.

Acknowledgements

The work described in this paper was substantially supported by a grant from the Research Grants Council of the Hong Kong Special Administrative Region, China (Project No. HKUST/HKU 6195/98H).

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