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Information Technology Acceptance by Individual Professionals: A Model Comparison Approach*

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ABSTRACT

The proliferation of innovative and exciting information technology applications that target individual "professionals" has made the examination or re-examination of existing technology acceptance theories and models in a "professional" setting increasingly important. The current research represents a conceptual replication of several previous model comparison studies. The particular models under investigation are the Technology Acceptance Model (TAM), the Theory of Planned Behavior (TPB), and a decomposed TPB model, potentially adequate in the targeted healthcare professional setting. These models are empirically examined and compared, using the responses to a survey on telemedicine technology acceptance collected from more than 400 physicians practicing in public tertiary hospitals in Hong Kong. Results of the study highlight several plausible limitations of TAM and TPB in explaining or predicting technology acceptance by individual professionals. In addition, findings from the study also suggest that instruments that have been developed and repeatedly tested in previous studies involving end users and business managers in ordinary business settings may not be equally valid in a professional setting. Several implications for technology acceptance/adoption research and technology management practices are discussed.

Subject Areas: Information Technology Acceptance, LISREL, Professional Users, Structural Equation Models, and Technology Adoption and Management.

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INTRODUCTION

The recent development of information technology applications that target highly specialized individual professionals, such as physicians and lawyers, has proliferated substantially. Considering the rapid growth of these innovative technology applications that target individual professionals, it is important to examine the extent to which existing theories can explain or predict their technology acceptance. In this vein, the current study represents a conceptual replication of some previous model comparison studies (e.g., Davis, Bagozzi, & Warshaw, 1989; Mathieson, 1991; Taylor & Todd, 1995a) by re-examining prevalent theoretical models in a healthcare setting that involves different users and technologies. Specifically, this study empirically tests the applicability of three theoretical models: the Technology Acceptance Model (TAM) (Davis, 1989; Davis et al., 1989), the Theory of Planned Behavior (TPB) (Ajzen, 1985, 1991), and a decomposed TPB model that is potentially adequate for the targeted professional context. Our investigative focus is the extent to which each model can explain physicians' acceptance of telemedicine technology.

BACKGROUND OVERVIEW

In this study, telemedicine refers to the use of information and telecommunication technologies to deliver timely healthcare services through electronic transmission of the needed expertise and information among geographically dispersed parties, including physicians and patients (Bashshur, 1995). Pioneering telemedicine applications can be traced back over four decades. Most early projects failed to meet expectations due to a host of factors that included nascent and primitive infrastructures, unsophisticated technology, premature funding termination, and limited technology acceptance (Bashshur, 1997). As concluded by Perednia and Allen (1995), the ultimate success of telemedicine as a viable alternative service delivery mode requires an adopting organization to address both technological and managerial challenges.

Of particular interest to the current study is technology acceptance, a fundamental managerial challenge in telemedicine technology implementation. Physicians are important users of telemedicine technology, and their acceptance is often crucial to the technology implementation success. As Keen (1991, p. 220) emphasized, "it is not the software but the human side of the implementation cycle that will block progress in seeing that the delivered systems are used effectively." This technology acceptance issue has been examined by researchers from the telemedicine community (e.g., Allen, Hayes, Sadisvan, Williamson, & Wittman, 1995; Mairinger, Gabl, Derwan, Mikuz, & Ferrer-Roca, 1996; Mitchell, Mitchell, & Disney, 1996; Gschwendtner, Netzer, Mairinger, & Mairinger, 1997; Mairinger, Netzer, Schoner, & Gschwendtner, 1998). A review of these studies and others, however, suggests limitations in scope (e.g., medical specialty areas examined) and scale (e.g., sample size) and the theoretical foundations of the hypotheses formulations. Toward this direction, this study addresses these limitations by examining two prevalent theories (i.e., TAM and TPB) for investigating individual technology acceptance/adoption in the "telemedicine" context.

RESEARCH SCOPE AND INVESTIGATED MODELS

In this study, we view technology acceptance as an individual's psychological state with regard to his or her voluntary or intended use of a particular technology (Gattiker, 1990). We choose "intention to use" as the dependent variable for both theoretical and practical reasons. Theoretically speaking, considerable prior studies have reported a strong and significant causal link between behavioral intention and targeted behavior (Sheppard, Harwick, & Warshaw, 1988; Venkatesh & Morris, 2000). Given this strong link, use of behavioral intention as a dependent variable to examine technology acceptance is theoretically justifiable (Mathieson, 1991). Agarwal and Prasad (1999) also argued that given a survey-based research design (which our study adopted), intentions are more appropriate than actual usage as "they are measured contemporaneously with beliefs" (p. 367). Pragmatically, the telemedicine development in our study site (i.e., Hong Kong) was in an early stage at the time of the data collection and, therefore, large-scale technology implementations had not yet occurred. Thus, choice of intention over actual technology usage as a dependent variable is considered adequate and desirable, allowing a timely investigation of a physician's acceptance at a time when a fast-growing number of healthcare organizations (in Hong Kong and elsewhere) were implementing telemedicine technology or considering (evaluating) the technology adoption.

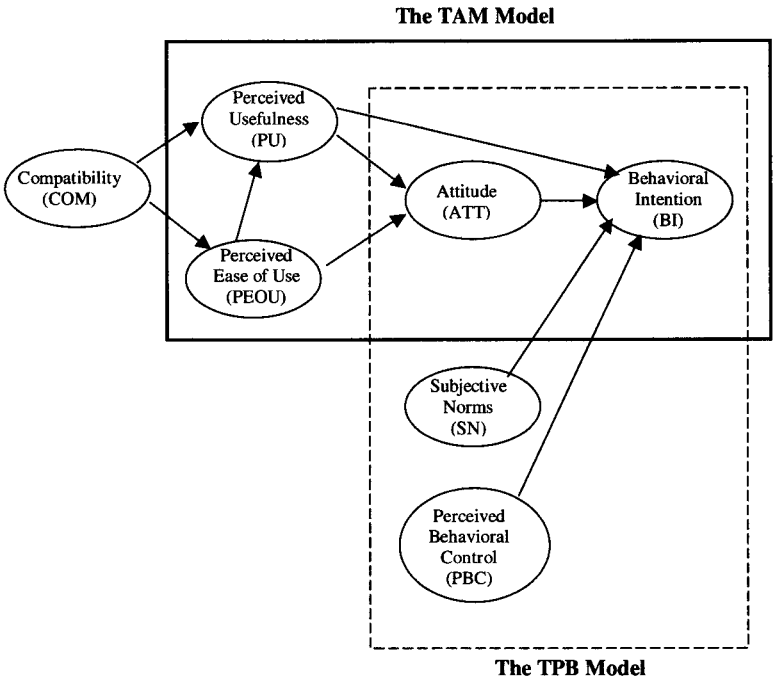
The particular models included in this comparative study are all based on behavioral intention, which has emerged as a common anchor for examining individual technology acceptance and adoption. A fundamental intention-based theory is the Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975). According to TRA, beliefs influence attitudes, which in turn shape intentions, which then guide or dictate behaviors. Both TPB and TAM are derived from TRA and have gained substantial empirical support through results from studies on a wide assortment of users and technologies. The specific models examined in the study are TPB, TAM, and a decomposed TPB (as shown in Figure 1).

Theory of Planned Behavior (TPB)

TPB extends from TRA by incorporating an additional construct, namely perceived behavioral control, to account for situations in which an individual lacks substantial control over the targeted behavior (Ajzen, 1991). According to TPB, an individual's behavior can be explained by his or her behavioral intention, which is jointly influenced by attitude, subjective norms, and perceived behavioral control. Perceived behavioral control also has a direct effect on behavioral intention. In our context, TPB suggests that a physician's intention to use telemedicine technology is jointly determined by his or her (1) positive or negative evaluative affect about using the technology; (2) perception of relevant others' opinions on whether or not he or she should use the technology; and (3) perception of the availability of skills, resources, and opportunities necessary for using the technology. Because of the described intention evaluation focus, our study tests TPB without its last construct; namely, actual behavior.

Attitude refers to an individual's positive or negative evaluative affect about performing a particular behavior. In our case, a physician's intention to use

Figure 1: Research models.



telemedicine is determined by his or her attitude towards using the technology. Subjective norms refer to an individual's perception of relevant others' opinions on whether or not he or she should perform a particular behavior. Consequently, these opinions become the individual's normative beliefs with which he or she would comply. Physicians who embrace comparable normative beliefs may vary considerably in the extent to which they want or are willing to comply with these beliefs. That is, physicians may exhibit differential motivations for complying with relevant others' opinions on the use of telemedicine technology. Perceived behavioral control is a construct unique to TPB and refers to an individual's perceptions of the presence or absence of requisite resources or opportunities necessary for performing a behavior (Ajzen & Madden, 1986). Broadly, a control belief is a perception of the availability of skills, resources, and opportunities necessary for performing the behavior under discussion. In our case, a physician's intention to use telemedicine technology may be affected by such perceived control factors as training and resources.

Technology Acceptance Model (TAM)

Adapted from TRA, TAM was developed specifically for explaining and predicting individual acceptance of computer technology (Davis, 1989; Davis et al., 1989). Broadly, TAM posits that the intensity of an individual's intention to use a

technology can be explained jointly by his or her perception about the technology's usefulness and attitude towards the technology use. As depicted in Figure 1, the degree to which telemedicine technology is easy to use, as perceived by a physician, affects his or her perception of how useful the technology would be as well as his or her attitude towards using the technology. Attitude is also directly influenced by a physician's perceived usefulness of the technology. Because of the described evaluation focus, this study examined TAM in the original form but without its last construct; that is, actual behavior.

Several recent studies that used TAM as a theoretical basis or framework suggested the exclusion of attitude from the model. For instance, Venkatesh and Davis (1996) removed attitude from their revised model because attitude did not appear to mediate fully the effect of perceived usefulness and perceived ease of use on behavioral intention as originally anticipated. The revised model (i.e., TAM without the attitude construct) has been applied and tested in several subsequent user technology acceptance/adoption investigations, including Venkatesh (1999, 2000), Venkatesh and Davis (2000), and Venkatesh and Morris (2000). In this study, we retained "attitude" in our examination of TAM for two reasons. First, the retention of attitude facilitated the intended conceptual replication of the studies by Davis et al. (1989), Mathieson (1991), and Taylor and Todd (1995a), all of which included attitude in their examinations of TAM. Second, given the relatively high autonomy and professional control (or even dominance) common to many healthcare settings, attitudinal beliefs and assessments might assume an increasingly important role in individual physicians' technology acceptance decisions. Hence, inclusion of the factor, rather than exclusion of it, can allow an examination of this proposition.

A Decomposed TPB Model

The third model under investigation is a decomposed TPB model. Using TPB to provide a basic structure, this model decomposes attitude by incorporating perceived usefulness and perceived ease of use as its mediating variables. Also included in the model is compatibility, which serves as an antecedent of both perceived usefulness and perceived ease of use.

The inclusion of perceived usefulness and perceived ease of use as mediating variables of attitude in the decomposed model is supported theoretically and empirically. In a nutshell, both TPB and TAM include attitude as a fundamental determinant of behavioral intention. Moreover, considerable empirical evidence has been accumulated, suggesting the significance and magnitude of the effects of perceived usefulness and perceived ease of use on attitude (e.g., Mathieson, 1991; Keil, Beranek, & Konsynski, 1995; Taylor & Todd, 1995a, 1995b; Szajna, 1996; Igbaria, Zinatelli, Gagg, & Cavaye, 1997).

Compatibility has been identified as an essential factor for innovation adoption (Rogers, 1995) and, thus, is also included in the decomposed model. The significant effect of compatibility on user technology acceptance/adoption decision has been reported by many prior studies, including Tornatzky and Klein (1982), Cooper and Zmud (1990), Iivari (1995), Rogers (1995), and Taylor and Todd (1995a). Moore and Benbasat (1991) reported a strong relationship between compatibility and relative advantage, which is largely congruent with perceived usefulness in the

context of TAM. More recently, Venkatesh and Davis (2000) examined the importance of compatibility in individual technology acceptance, extending perceived usefulness by incorporating additional constructs that span the cognitive instrumental process. Of particular importance are job relevance and output quality, both of which are pertinent to compatibility.

In this study, compatibility refers to the degree to which the use of telemedicine technology is perceived by a physician to be consistent with his or her work practices. Broadly, the practice of a physician follows a pigeonhole process, consisting of contingency categorization, standard program selection, and execution phases. Over time, a physician becomes increasingly accustomed to and deeply entrenched in a particular practice style and, thus, is unlikely to accept a technology that is incompatible (or perceived to be incompatible) with his or her work practices. The described compatibility may affect technology acceptance through its influence on perceived usefulness and perceived ease of use. Understandably, physicians are likely to "recognize" the usefulness of a technology when it is perceived to be compatible with their work practices. At the same time, physicians are likely to consider a technology easy to use when its inclusion does not require major changes in their practices. Significant incompatibility necessitates major process/service changes that often require considerable learning and unlearning on the part of physicians who, as a result, are likely to perceive the technology to be not easy to use. Thus, compatibility may favorably affect both perceived usefulness and perceived ease of use.

The described decomposed model resembles the model proposed by Taylor and Todd (1995a). However, our model decomposition focuses on attitude rather than subjective norms or perceived behavioral control. The selected or confined decomposition can be explained as follows. First, physicians provide specialized services in a professional manner and often have relatively high autonomy in their practices, including the use of a technology. Managers and peers may affect a physician's technology acceptance decision but perhaps not to an extent of profound significance. The described autonomy, together with the specialized training that encourages independent thinking and decision making, may result in physicians' tendency toward respecting relevant others' opinions on using telemedicine technology, but placing relatively less weight on these opinions when evaluating or making technology acceptance decisions. In this light, subjective norms are expected to assume a relatively less important role in physicians' technology acceptance decisions, as compared with that of typical end users and business managers. The diminished role of subjective norms thus makes that decomposition unattractive.

Similarly, the "intrinsic" effects of perceived behavioral control in a healthcare professional context also may not warrant its decomposition. As Mintzberg (1983) commented, the knowledge base of a healthcare organization is sophisticated but its technical system, the set of technologies and instruments used to apply the knowledge base, is not complicated (and nor can it be). In a typical healthcare setting, physicians have substantial control over the resources and operational conditions important to their technology use. They usually have relatively strong staff support from nurses and technicians for providing assistance in the operations of medical equipment and associated technologies. Together, these characteristics

and others unique to healthcare professional settings make the decomposition of perceived behavioral control less appealing.

RESEARCH DESIGN

Measures

The measures used to operationalize the constructs included in the investigated models were mainly adapted from relevant prior studies, with minor wording changes to tailor them to the targeted context. Items for perceived usefulness, perceived ease of use, and behavioral intention were adapted from Davis (1989); items for attitude, subjective norms, perceived behavioral control, and compatibility were from Taylor and Todd (1995a). Moreover, constructs common to the examined models were measured using the same scales, an approach suggested by Taylor and Todd (1995a), in which identical scales were used to focus the model comparison on substantive rather than measurement concerns. All items were measured using a 7-point Likert-type scale with anchors on *strongly agree* and *strongly disagree*, respectively. To ensure desired balance and randomness of the items in the questionnaire, half of the items were negated and all items were randomly arranged to reduce the potential ceiling (or floor) effect that induces monotonous responses to the items designed to measure the same construct.

Pretests

Pretests were conducted to ensure that the instrument possessed acceptable validity. First, three physicians from different specialty areas and public tertiary hospitals were asked to evaluate the instrument's content validity. Using the card-sorting method described by Moore and Benbasat (1991), all question items included in the instrument were printed on 8cm x 6cm index cards. The cards were shuffled and presented to the physicians, each of whom was asked individually to sort them into appropriate categories (that represented the respective underlying constructs). Results from the card-sorting evaluation were satisfactory, as the physicians were able to categorize the presented question items with an accuracy rate of 90% or better.

With satisfactory content validity established, the instrument was further tested for reliability, item consistency, ease of understanding, and question sequence appropriateness. Another 35 physicians were asked to complete the questionnaire. Based on the responses from this group of physicians, the instrument's reliability was assessed using Cronbach's alpha. The resulting alpha values ranged from .62 to .85, which were considered to be acceptable for pretests. Comments on or suggestions about the question sequence, wording choices, and measures were also solicited, leading to several minor modifications to the questionnaire. Based on the pretest subjects' feedback, several items were removed from our instrument. Table 1 lists the final questionnaire items used to measure each construct, together with their sources of reference. Subjects who had participated in the pretests were excluded from the subsequent formal study.

Table 1: Summary of measurement scales.

Construct	Measure	Source	Mean	*SD*	Factor Loading	Construct Reliability
Attitude (ATT)						
ATT1	• Using telemedicine technology in patient care and management is a good idea.	Taylor	2.83	1.03	.71	
ATT2	• Using telemedicine technology in patient care and management is unpleasant.	& Todd	2.96	1.16	.64	.69
ATT3	• Using telemedicine technology is beneficial to my patient care and management.	(1995a)	2.59	1.15	.60	
Subjective Norms (SN)						
SN1	• People who are important to my health care services think that I should not use telemedicine technology.	Taylor & Todd	3.30	1.03	.97	.84
SN2	• People who are important in assessing my patient care and management think that I should not use telemedicine technology.	(1995a)	3.36	1.07	.72	
Perceived Behavioral Control (PBC)						
PBC1	• I would have the ability to use telemedicine technology in my patient care and management.	Taylor & Todd	2.85	1.08	.73	
PBC2	• I would not have the knowledge to make use of telemedicine technology in my patient care and management.	(1995a)	3.94	1.34	.47	.52
PBC3	• I would have the resources (including training) to make use of telemedicine technology in my patient care and management.		2.88	1.39	.33	
Perceived Usefulness (PU)						
PU1	• Using telemedicine technology cannot improve my patient care and management.	Davis	2.80	1.17	.85	
PU2	• Using telemedicine technology cannot enhance my effectiveness in patient care and management.	(1989)	3.04	1.20	.81	.86
PU3	• I would find telemedicine technology not useful for my patient care and management.		2.93	1.16	.82	

Table 1: (continued) Summary of measurement scales.

Construct	Measure	Source	Mean	*SD*	Factor Loading	Construct Reliability
Perceived Ease of Use (PEOU)						
PEOU1	• Learning to operate telemedicine technology would not be easy for me.	Davis	3.02	1.30	.83	
PEOU2	• It is not easy for me to become skillful in using telemedicine technology.	(1989)	3.11	1.60	.66	.76
PEOU3	• I find telemedicine technology easy to use.		3.21	1.18	.67	
Compatibility (COM)						
COM1	• Using telemedicine technology fits with the way I work.	Taylor &	3.46	1.30	.78	
COM2	• Using telemedicine technology does not fit with my practice preferences.	Todd	3.23	1.24	.73	.84
COM3	• Using telemedicine technology fits with my service needs.	(1995a)	3.28	1.16	.88	
Behavioral Intention (BI)						
BI1	• I intend to use telemedicine technology for patient care as often as needed.	Davis	3.47	1.28	.80	.77
BI2	• To the extent possible, I would use telemedicine technology in my patient care frequently.	(1989)	3.23	1.26	.78	

Subjects

The target subjects were physicians who practiced at public tertiary hospitals in Hong Kong. Subject choice was made primarily based on the likelihood of their involvement with telemedicine programs and of becoming targeted users. As a group, physicians at public tertiary hospitals in Hong Kong have considerable interorganizational service needs that can be effectively supported by telemedicine technology. Examples of common service needs include second or specialist opinion solicitations, patient transfer or admission assessment, team-based collaborative patient management, and urgent care in a medical emergency (Liu, Sheng, Hu, Higa, Au, & Wei, 1997; Liu Sheng, Hu, Wei, Higa, & Au, 1998).

Study Administration

Before sending out the questionnaires, an encounter letter that explained the purpose of the study and ensured the necessary confidentiality was sent to the chiefs of service in 70 clinical departments housed in the targeted tertiary hospitals. Personal visits and/or telephone calls were then made to these chiefs to provide detailed study information and solicit their support. Forty-one of these contacted departments agreed to participate in the study. With the assistance of the chiefs of service, questionnaire packets were delivered to individual physicians practicing in the participating departments. Each packet contained a cover letter stating the purpose of the study and intended use of the data, two endorsement letters (from the Hong Kong Telemedicine Association and the Hong Kong Hospital Authority, respectively), the questionnaire, and selected telemedicine technology references. A letter soliciting internal promotion of the study was faxed to the chiefs of service of the participating departments immediately after the questionnaire distribution. Each subject was asked to return the completed questionnaire to his or her department secretary, from whom the questionnaire was collected at a later time.

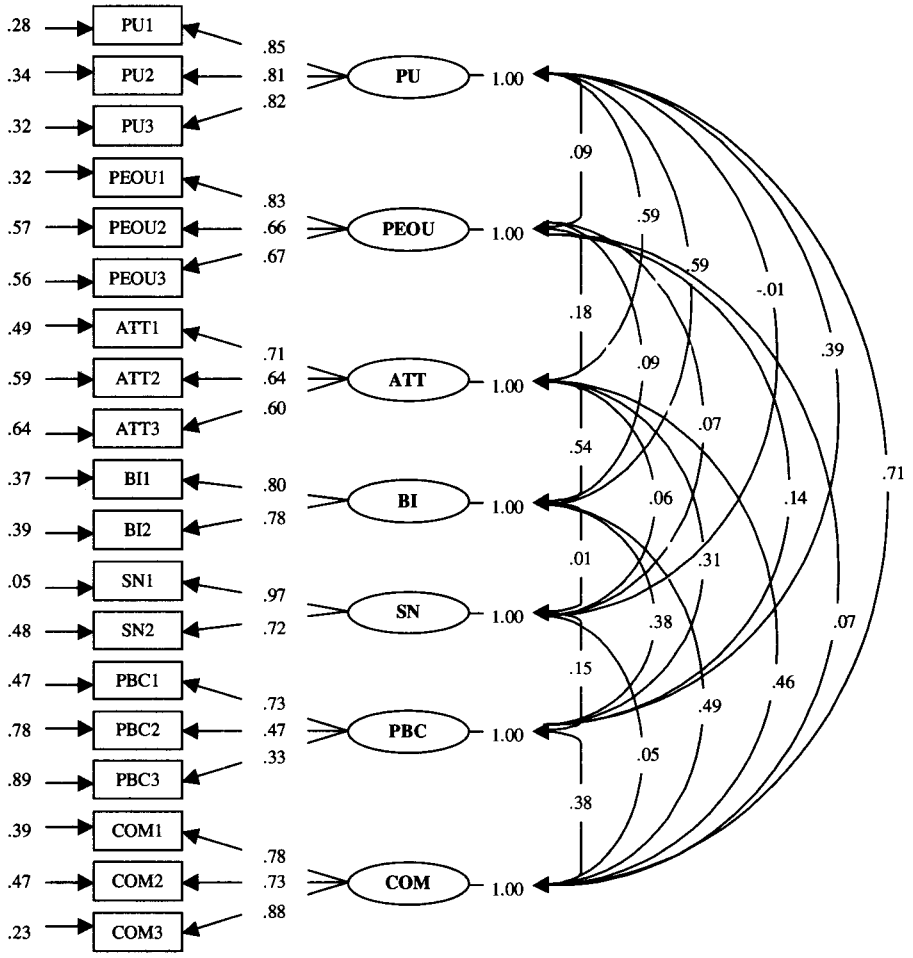
Of the 1,728 questionnaires distributed, 421 were returned. Thirteen of them were partially completed and, therefore, discarded. Thus, effective responses totaled 408, showing a 23.6% response rate. Seventy-five percent of the respondents were male, and the majority of them had received their medical 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 respective specialty areas.

DATA ANALYSIS AND RESULTS

Measurement Model

The measurement model was first assessed by a confirmatory factor analysis using LISREL 8.30 and the sample correlation matrix. Six common model-fit measures were used to assess the model's overall goodness of fit: chi-square/degree of freedom, goodness-of-fit index, adjusted goodness-of-fit index, non-normed fit index, comparative fit index, and standardized root mean square residual. As shown in Figure 2, all the model-fit indices exceeded their respective common acceptance levels suggested by previous research (Chau, 1997), thus demonstrating that the measurement model exhibited a fairly good fit with the data collected.

Figure 2: Measurement model.



	Recommended Value
Chi-square / degree of freedom: 1.53	≤ 3.0
Goodness-of-Fit Index (GFI): .95	≥ .90
Adjusted Goodness-of-Fit Index (AGFI): .93	≥ .80
Non-Normed Fit Index (NNFI): .96	≥ .90
Comparative Fix Index (CFI): .97	≥ .90
Standard Root Mean Square Residual (SRMSR): .034	≤ .10

The model was further assessed for construct reliability and validity. Construct reliability can be calculated as follows: (square of the summation of the factor loadings)/{(square of the summation of the factor loadings) + (summation of error variances)}. The interpretation of the resultant coefficient is similar to that of Cronbach's alpha, except that it also takes into account the actual factor loadings rather than assuming that each item is equally weighted in the composite load determination. As shown in Table 1, with the exception of perceived behavioral

control, construct reliability for all the factors in our measurement model was above or close to .70, an acceptable threshold suggested by Nunnally and Bernstein (1994).

Construct validity was evaluated by examining the factor loadings within the constructs as well as the correlation between the constructs (Anderson & Gerbing, 1988). With the exception of perceived behavioral control, the factor loadings on all the constructs were largely satisfactory along the expected direction (i.e., ranged between .60 to .97), thus providing evidence of satisfactory or acceptable item convergence on the intended constructs. Correlation between constructs ranged from –.01 to .71, with the confidence intervals all below unity, thereby providing empirical support for the discriminant validity of the measures.

Model Testing Results

Following the satisfactory model evaluation results, we examined and compared the investigated models. Table 2 summarizes the degree to which each model fit the data. All goodness-of-fit indices exceeded their respective common acceptance levels, suggesting that all three models exhibited a good fit with the data. TAM appears to be superior to TPB in explaining a physician's intention to use telemedicine technology; that is, R^2_{BI} = .40 and .32 for TAM and TPB, respectively. The decomposed TPB (R^2_{BI} = .42) is better than TAM but the difference is not substantial. Jointly, perceived usefulness and perceived ease of use explained 36% of the variance in attitude in TAM and 37% of that in the decomposed TPB. The addition of compatibility in the decomposed TPB model significantly increased the accounted variance in perceived usefulness (from R^2_{PU} = .01 for TAM to R^2_{PU} = .53 for the decomposed model). However, compatibility explained only 1% of the variance in perceived ease of use.

Table 3 shows the path coefficients for each model, together with their respective significance. Two observations are worth discussion. First, the path significance was consistent across all the investigated models. That is, a path found to be significant in one model remained so in the other two models and, similarly, a path not significant in one model remained insignificant in the others. Second, all significant paths had relatively high statistical significance levels: 8 of the 10 paths were significant at a .001 level, and the remaining two were at a .01 level.

The path from attitude to behavioral intention was significant in all three models. Perceived usefulness was a significant determinant of attitude and behavioral intention in both TAM and the decomposed TPB model. Perceived ease of use, on the other hand, showed no significant effects on attitude or behavioral intention in any of the investigated models. In addition, the path from perceived behavioral control to behavioral intention was significant in TPB as well as the decomposed TPB model. The path from subjective norms to behavioral intention was not significant in either TPB or decomposed TPB. Finally, compatibility was found to be a significant determinant of perceived usefulness but not perceived ease of use.

Table 3 also summarizes the effects of all the constructs (factors) examined. Across the models investigated, perceived usefulness exhibited the strongest direct and total effects on behavioral intention. Attitude, despite showing a slightly weaker direct effect than perceived usefulness on behavioral intention across all

Table 2: Overall fit and explanatory power of the models.

	Recommended Value	TPB	TAM	Decomposed TPB
Fit Index				
Chi-square/*df*	≤ 3.0	1.23	1.74	1.55
GFI	≥ .90	.98	.97	.95
AGFI	≥ .80	.97	.95	.93
NNFI	≥ .90	.99	.97	.96
CFI	≥ .90	.99	.98	.97
SRMSR	≤ .10	.04	.03	.04
Explanatory Power				
R^2_{BI}	–	.32	.40	.42
R^2_{ATT}	–	–	.36	.37
R^2_{PU}	–	–	.01	.53
R^2_{PEOU}	–	–	–	.01

Table 3: Significance and strengths of individual paths.

	TPB	TAM	Decomposed TPB
Path Coefficient			
ATT → BI	.63**	.42**	.37**
SN → BI	–.00	–	–.00
PBC → BI	.22*	–	.22*
PU → BI	–	.42**	.39**
PU → ATT	–	.41**	.43**
PEOU → PU	–	.09	.03
PEOU → ATT	–	.09	.09
COM → PU	–	–	.70**
COM → PEOU	–	–	.08
Effect on Behavioral Intention			
Direct Effect			
PU	–	.42	.39
ATT	.63	.42	.37
SN	–.00	–	–.00
PBC	.22	–	.22
Indirect Effect			
PU	–	.17	.16
PEOU	–	.09	.05
COM	–	–	.39
Total Effect			
PU	–	.59	.55
PEOU	–	.09	.05
ATT	.63	.42	.37
SN	–.00	–	–.00
PBC	.22	–	.22
COM	–	–	.39

*p-value < .01 **p-value < .001

models, exhibited a stronger effect on intention than that of perceived behavioral control. The indirect effect of compatibility on behavioral intention was particularly interesting. Through its strong direct effect on perceived usefulness, compatibility exhibited an indirect effect on intention that was greater than the direct effect of attitude on intention.

DISCUSSION

Judged by its direct and indirect (i.e., via attitude) effect on behavioral intention, perceived usefulness was found to be the most significant factor for physicians' acceptance of telemedicine technology. This finding is consistent with the results from several recent studies of TAM that suggest that perceived usefulness is more important than perceived ease of use in determining whether or not to use a technology (Keil et al., 1995; Chau, 1996; Venkatesh, 2000). Physicians tend to concentrate on the usefulness of a technology and, thus, may be fairly "pragmatic" in developing general attitudes towards using the technology. In our context, an essential acceptance criterion is whether or not telemedicine technology fills the needs of an individual physician. The described evaluation criterion or rationale may be, in part, rooted in physicians' tendency to view technologies as tools, acceptable only when proven to provide desired utility to a medical practice.

Contrary to the assertion of TAM and the findings reported by some prior research (e.g., Venkatesh, 1999), perceived ease of use was not found to have any significant effects on perceived usefulness or attitude. This finding is interesting and worth noting. As a group, physicians might differ subtly from the subjects commonly examined in prior technology acceptance/adoption studies (e.g., administrative and clerical staff, knowledge workers, and system developers) in such areas as general competence, adaptability to new technologies, mental and cognitive capacity, and work arrangement and nature. Conceivably, physicians can comprehend a new technology quickly and become familiar with its operations without going through training as intense as that commonly required by other user populations. As a consequence, physicians might not consider perceived ease of use an issue of particular importance. As Keil et al. (1995) concluded in their study, "no amount of EOU [ease of use] will compensate for low usefulness" (p.89). Alternatively, the finding might suggest the limitations of TAM in situations where users exhibit relatively superior general competence and mental capacity, or have constant and reliable access to staff assistance in technology operations. In this vein, the explanatory power of TAM, especially the utility of perceived ease of use, may weaken as the user's general competence or staff support increases.

Attitude was found to be another important factor influencing physicians' intention for using telemedicine technology. This finding may highlight the crucial role of attitude in technology acceptance by individual professionals, thus suggesting an interesting or subtle characteristic potentially differentiating their decision-making processes from those of user populations commonly found in business settings. The observed importance of attitude might be, in part, attributed to specialized training, autonomous practice, and professional work arrangements.

Subjective norms were found to have no significant effects on behavioral intention. This finding was consistent with Davis et al. (1989) and Mathieson (1991) but not with Taylor and Todd (1995a), and Harrison, Mykytyn, and Riemenschneider (1997). Taylor and Todd (1995a) commented that the inconsistent results reported by several prior studies may, in part, have resulted from the use of student subjects, whose perception of real consequences associated with the targeted behavior can be unduly influenced by relevant others, including professors and peers. In this connection, the physicians in our study have specialized training and practice in a highly autonomous profession, both of which contribute to the development of independent thinking and a probable tendency of placing relatively less weight on relevant others' opinions, as compared with their student-subject counterparts. Thus, the described professional nature may, in part, explain the observed insignificant effects of subjective norms on behavioral intention.

Consistent with findings from several prior studies (Mathieson, 1991; Taylor & Todd, 1995a), perceived behavioral control was found to have significant direct effect on behavioral intention, though this effect was weaker than that of perceived usefulness or attitude. This finding is consistent with the results from Taylor and Todd's (1995b) investigation of the role of prior experience in affecting IT usage, in which they concluded that "inexperienced users tend to discount control information in the formation of intentions, relying instead primarily on perceived usefulness" (p.566). At the time of the data collection, physicians in Hong Kong had varying levels of experience with telemedicine technology. The observed relatively weak influence of perceived behavioral control may also be, in part, explained by the characteristics of telemedicine developments in Hong Kong. Most, if not all, of the targeted tertiary hospitals had a fairly sophisticated in-house technology base and reasonable access to resources. Although convenient access and user training and support are important, in general they may not represent central concerns to some of the physicians included in the study.

Finally, compatibility appeared to be a significant determinant of perceived usefulness but not perceived ease of use. As shown in Table 3, the indirect effect of compatibility on intention was comparable to the direct effect of perceived usefulness on intention and was greater than the direct effect of attitude on intention. This finding might imply that the compatibility of a telemedicine technology with a physician's practice routine is a crucial antecedent to his or her perceived technology usefulness. Subsequently, compatibility assumes an important role in the physician's development of a general attitude towards using the technology.

LIMITATIONS

This empirical study has several limitations. First, investigation of telemedicine technology adoption is relatively new to IS researchers. The discussed findings and their implications are obtained from one single study that examined a particular technology and targeted a specific professional user group. Thus, caution needs to be taken when generalizing our findings and discussion to other technologies or professional groups.

Second, our operationalization of the constructs included in the investigated models was basically drawn from relevant prior research. This approach has the

merit of using previously established and validated measures and is crucial to our "replication" intention. However, the relatively lower reliability values of some scales (particularly perceived behavioral control), as compared with those reported by prior studies, suggest probable limitations or applicability of a previously validated instrument across different contexts or targeted user groups. This limitation corresponds to the importance of instrument re-evaluation discussed by Straub (1989) and, therefore, reinforces its importance. The poor reliabilities may also be a function of the limited sample size.

Compared with prior studies examining TAM and TPB, the relatively low *R*-square reported by the current research represents another limitation; that is, 40% in our study, 52% in Taylor and Todd (1995a), and 70% in Mathieson (1991). In turn, this limitation may suggest a general constraint of TAM or TPB in explaining or predicting technology acceptance by individual professionals, and its mitigation may require the inclusion of additional factor(s) in the respective models.

CONCLUSIONS

This study represents a conceptual replication of several previous model comparison studies by re-examining prevalent theoretical models in healthcare settings that involve physicians and telemedicine technology. The findings suggest several implications. First, findings of the study provide evidence that highlights plausible limitations of TPB and TAM in a professional context. The decomposed TPB model, which in effect has incorporated factors from both TPB and TAM, did not appear to substantially increase the power or utilities to explain or predict behavioral intention. The described limited explanatory utility is important, suggesting the need for a broader exploration of factors beyond TPB and TAM. Nevertheless, this study has responded to the call for additional theory-testing efforts by re-examining the research results from previous model comparison studies in a healthcare professional context (Hartwick & Barki, 1994b).

Results from the study also shed light on interesting or subtle differences in technology acceptance decision making between professional and ordinary users. Professionals are found to be pragmatic, concentrating more on the usefulness of a technology than on its ease of use, considering technology-practice compatibility to be crucial, and attaching limited weight to suggestions or opinions from relevant others. The study has the merits of conducting a technology acceptance investigation in a real-world healthcare setting that involved individual physicians and an emerging technology of enormous significance. Nevertheless, the observed differences in technology acceptance decision making may also be attributed to factors pertinent to culture, technology, time, or others.

Continued research is needed to address these limitations and others. In particular, further investigations of constructs that plausibly account for the remaining (i.e., unexplained) variance in behavioral intention are important. Additional constructs might include self-efficacy (Compeau & Higgins, 1995; Venkatesh & Davis, 1996; Compeau, Higgins, & Huff, 1999), user participation and involvement (Hartwick & Barki, 1994a), prior usage and experience (Thompson, Higgins, & Howell, 1994; Taylor & Todd, 1995b), perceived voluntariness (Agarwal & Prasad, 1997), personal innovativeness (Agarwal & Prasad, 1998), and user char-

acteristics (Igbaria et al., 1997). Another alternative may be testing new models or theories. In Moore and Benbasat (1991), constructs from both Rogers' (1995) innovation diffusion theory (i.e., a communication approach) and TAM (i.e., an intention-based approach) were integrated to develop an instrument to measure individuals' perceptions of IT innovation adoption. In addition, Mathieson (1991) suggested the use or applicability of social network theory (Roberston, 1989) for improving our understanding of the technology acceptance decision.

Additional research efforts are also needed to evaluate the validity of the investigated models and our findings. Conducting a series of studies that target a variety of professional contexts, as defined by the technology and/or the user group, over a period of time is desirable. Longitudinal evidence obtained thereby might enhance our understanding of the causality or interrelationships between or among decision variables important to technology acceptance by individual professionals.

From a managerial standpoint, our findings suggest that cultivating positive attitudes toward using the technology as well as positive perceptions of the technology's usefulness are important for fostering physicians' acceptance of telemedicine technology. Therefore, once a healthcare organization has decided to adopt a telemedicine technology, the management should put strong emphasis on demonstrating and communicating the technology's usefulness to its physicians. The significance of compatibility on perceived usefulness may also reflect the difficulty in changing physicians' practice routines learned from their systematic and rigorous training. Thus, management needs to formulate implementation strategies that would increase the likelihood of a physician's seeing telemedicine technology as compatible with his or her work practices.

Finally, the insignificance of subjective norms suggests that physicians, in general, may rely highly on their own assessments in making technology acceptance decisions. As a result, opinions and suggestions by relevant others might not have dominant or profound influences in their decision making. This may be partially due to the early stage of telemedicine developments in Hong Kong, where not many physicians would be considered by their peers as "gurus" in the area. In this situation, when the technology is introduced into an organization, the focus should not be on who has used it, is using it, or would like to see it used; rather, the emphasis should be on how useful the technology could be with respect to the targeted physicians' practices and service needs. [Received: June 20, 2000. Accepted: August 16, 2001.]

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