Examining a Model of Information Technology Acceptance by Individual Professionals: An Exploratory Study

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ABSTRACT: The recent proliferation of information technology designed to support or enhance an individual professional's task performance has made the investigation of technology acceptance increasingly challenging and significant. This study investigates technology acceptance by individual professionals by examining physicians' decisions to accept telemedicine technology. Synthesized from relevant prior research, a generic research framework was built to provide a necessary foundation upon which a research model for telemedicine technology acceptance by physicians could be developed. The research model was then empirically examined, using data collected from more than 400 physicians practicing in public tertiary hospitals in Hong Kong. Results of the study suggest several areas where individual "professionals" might subtly differ in their technology acceptance decision-making, as compared with end users and business managers in ordinary business settings. Specifically, physicians appeared to be fairly pragmatic, largely anchoring their acceptance decisions in the usefulness of the technology rather than in its ease of use. When making decisions to

Journal of Management Information Systems / Spring 2002, Vol. 18, No. 4, pp. 191–229.

0742–1222 / 2002 $9.50 + 0.00.

accept a technology, physicians expressed considerable concerns about the compatibility of the technology with their practices, placed less importance on controlling technology operations, and attached limited weight to peers' opinions about using the technology. Based on results obtained from this study, the initially proposed framework for technology acceptance by individual professionals was revised to a "hierarchical, three-layer" structure with the individual context at the inner core, the implementation context on the outermost layer, and the technological context residing in the middle. Implications for information systems research and telemedicine management practice that have emerged from the study's findings are also discussed.

KEY WORDS AND PHRASES: acceptance of information technology, adoption of information technology, professional users, telemedicine technology management.

THE USE OF INFORMATION TECHNOLOGY (IT) has expanded into many areas that can be broadly categorized by applications and target users. Driven by service improvement, market competitiveness enhancement, or bottom-line survival, business organizations have invested heavily in IT and are likely to continue doing so in the near future. Examples of prevalent or highly publicized IT applications for business include technology-enabled process reengineering, open systems, electronic data interchange, and more recently, Internet-based electronic commerce. In the meantime, various IT applications designed to support or enhance individual task performance and services within for-profit and not-for-profit professional organizations have also proliferated rapidly. This phenomenon—the fast-growing acquisition and implementation of innovative IT applications for individual professionals[1]—has demanded effective technology management from adopting organizations with which professional individuals are affiliated. A case in point is telemedicine technology, which supports patient care from a distance and distributed service collaboration of individual physicians from different health-care organizations.

Broadly speaking, telemedicine is an IT-based innovation that supports, facilitates, and potentially improves health-care professionals' care and services to clients, in most cases, their patients. Understandably, physicians are the principal users and stakeholders of telemedicine technology. Compared with end users and managers in ordinary business settings, these professionals may exhibit subtle differences in their technology acceptance decision-making. For instance, the extent to which attitude or peer influences affect physicians' technology acceptance decisions may differ from that common to their end user or business manager counterparts, in part because of specialized training, autonomous practices, and professional work arrangements. Prior technology acceptance/adoption research has concentrated on IT applications primarily designed or intended for "common" user groups that typically include end users, knowledge workers, and managers at various levels. Furthermore, most previous empirical studies have examined user technology acceptance in ordinary business organization contexts and thus have offered limited discussion on technology acceptance by individual professionals. As the development of IT applications specifically designed to support individual task performance and services within a professional context continues to grow at a rapid pace, the need for identifying essential factors potentially affecting individual professionals' technology acceptance decisions has become increasingly important.

This paper reports on an exploratory study that investigated the technology acceptance decisions of individual physicians in a health-care context. Synthesizing relevant prior research, we proposed a generic framework for technology acceptance by individual professionals. Based on the framework, a research model was developed to explain telemedicine technology acceptance by physicians.[2] The research model consisted of important technology acceptance decision factors and specified their plausible causal relationships. Because of its behavioral intention orientation and technology control consideration, the model had its theoretical premise established around the Technology Acceptance Model (TAM) and the Theory of Planned Behavior (TPB). Furthermore, the research model was supplemented by factors drawn or modified from other relevant theories or models, making it increasingly adequate for the target "professional" context. The model was then empirically examined, using data collected from a survey that involved more than 400 physicians practicing in public tertiary hospitals in Hong Kong.

The current work contributes to information systems (IS) research by supplementing the existing literature with insights into potential areas where professional user groups might differ from common user groups in their respective technology acceptance decision-making. Such differences in technology acceptance have become an increasingly important technology management issue that has not yet received adequate research attention. At a minimum, findings from this study provide theoretical groundings for and empirical evidence of probable directions for continued investigations of technology acceptance by individual professionals. Seeking a systematic conceptualization of technology acceptance by individual professionals, we proposed and then revised a generic framework upon which particular research models can be developed for different technologies, professional categories or user groups, or their combinations. From a managerial perspective, findings from this study may also advance our understanding and practice of the organizational management of telemedicine technology. Specifically, the study identified several factors essential to physicians' technology acceptance decisions and discussed their implications for formulating organizational strategies that encourage and foster technology acceptance among member physicians.

In the next section, we examine the background of the current research by describing the health-care system in Hong Kong. This background description is followed by a review of prior telemedicine research and the relevant technology acceptance literature, together with a discussion of our research motivations. A generic framework of technology acceptance by professionals is proposed and discussed next. The research model is then described, followed by a review of our study design and data collection procedure details. The discussion section presents the important results of the study. The paper concludes with a summary of the study's findings, its limitations and its implications for both IS research and telemedicine management by health-care organizations.

The Health-Care System in Hong Kong

THE HEALTH-CARE SYSTEM IN HONG KONG is largely dominated by public health-care establishments, which, to a large extent, are centrally planned and controlled and hierarchically organized for resource allocation efficiency and service effectiveness purposes. Central to the system is the Hospital Authority (HA), the supreme statutory body responsible for delivering a comprehensive range of secondary and tertiary specialist care and rehabilitation services through a network of health-care facilities. The HA is accountable to the Hong Kong government through the Secretary for Health and Welfare, who charts health policies and monitors the services and performance of the public health-care system. At the time of the study, the HA managed 44 public hospitals and health-care institutions (including eight tertiary hospitals) and 49 specialist outpatient centers. Managing more than 26,400 hospital beds, which translates to an average of 4.06 public hospital beds per 1,000 people, the HA employed approximately 48,500 full-time staff and operated under a recurrent budget of HK$26 billion in 1998–1999 (HK$7.8 equals US$1).

Individual physicians are employed by the HA and assigned to different hospitals and care centers. Typically, the position of a physician is based on rank, ranging from clinical administrator to junior medical officer. In spite of the formal rank-based hierarchy, physicians in a hospital or care center usually have high control over issues concerning their practices and services. Thus, physicians practice in a fairly independent manner and typically have high autonomy in patient care/management and service decision-making. To a great extent, physicians consider that the patient's well-being is their top priority and they would do whatever is medically necessary or appropriate for patients. Compared with their counterparts in the United States, physicians at tertiary hospitals or specialized care centers in Hong Kong are burdened by relatively heavy clinical loads and may need to work long hours on a routine basis.

In general, Hong Kong lacks health-care professionals in several subspecialty areas, including neurosurgery. Demand exceeding supply is common in these areas where service queues or backlogs are considerable; thus, resource allocation/utilization efficiency and service effectiveness are challenging management issues. For tertiary hospitals or specialized care centers, telemedicine represents an attractive alternative mode for service delivery or collaboration and may eventually help physicians become more effective in responding to patient care and service demands.

Literature Review and Research Motivations

IN THIS STUDY, TELEMEDICINE REFERS TO THE USE OF IT to support health-care services and activities via electronic transmission of the necessary information or expertise among geographically dispersed parties, including physicians and patients, in order to improve service effectiveness or resource allocation/utilization efficiency[3] [5]. Rapid technology advancements and continual increases in the performance-price index have significantly expanded the role of telemedicine technology in physicians' clinical decision-making and patient care and management. At the same time, persistent problems in health care that include service accessibility, quality, costs, and resource allocation, have also significantly contributed to telemedicine's economical attractiveness, social desirability, and political appeal. As a result, a fast-growing number of telemedicine projects and programs have been implemented or are under development around the globe [29].

The development of telemedicine in Hong Kong has significantly proliferated since the mid-1990s [32]. Several programs were initiated and ultimately established by proactive physicians who were in part motivated by factors interestingly different from those common to most rural-based telemedicine programs in the United States [32]. Driven mostly by urgent patient care demands and the needs for improved utilization efficiency (particularly in highly specialized facilities of limited service capacity), existing telemedicine programs in Hong Kong are largely urban-based and have a prominent tertiary care focus.

In their fairly comprehensive review of previous telemedicine research, Perednia and Allen [39] commented that, because of a predominant focus on technological developments and clinical applications, most prior research has offered limited discussion on important issues pertaining to organizational and managerial consideration (for example [3]). As the authors concluded, the ultimate success of telemedicine as a viable service collaboration and delivery alternative or as a routine means for physicians to manage patient care requires health-care organizations to address both technological and managerial challenges. One fundamental managerial challenge is user technology acceptance.

Investigations of user technology acceptance have been abundant in the IS literature. A review of relevant prior research has suggested that a fairly rich stream of technology acceptance/adoption studies is anchored in behavioral intention. According to the behavioral-intention approach, an individual's decision to accept/adopt a technology is a conscious act that can be sufficiently explained and therefore predicted by their behavioral intention. Following this reasoning, researchers are challenged to identify crucial determinants of an individual's intention toward accepting/adopting the technology. Several intention-based theories and models have been developed and empirically examined, including the Theory of Reasoned Action (TRA), TAM, and TPB.

Proposed by Fishbein and Ajzen [20], TRA postulates that beliefs influence attitude, which in turn shapes a behavioral intention guiding or even dictating an individual's behavior. TAM [17] shares with TRA the common thread that connects attitude to behavioral intention, but it differs considerably in the conceptualization of attitude and behavioral intention. According to TAM, behavioral intention is jointly determined by attitude and perceived usefulness, which together with perceived ease of use explain attitude. Broadly, TAM specifies general determinants of individual technology acceptance and therefore can be and has been applied to explain or predict individual behaviors across a broad range of end user computing technologies and user groups [18]. Because of its technology focus, TAM is appropriate for examining technology acceptance by individual professionals, but may need to be supplemented by other theories or models due to its intended generality and parsimony. TPB extends from TRA by incorporating an additional construct (that is, perceived behavioral control) to account for situations where an individual lacks the control or resources necessary for carrying out the targeted behavior freely [1]. Because of the behavioral control consideration, TPB is considered to be more general than TRA and, together with TAM, was selected to provide a necessary theoretical premise for the research model examined in this study.

A Generic Framework for Technology Acceptance by Individual Professionals

BASED ON FINDINGS FROM RELEVANT PRIOR RESEARCH, we propose here a generic framework for systematic analysis of technology acceptance by individual professionals. In turn, the framework provides a foundation upon which particular research models can be developed to account for different technology acceptance scenarios, as defined by distinct characteristics pertaining to technology, professional category or user group, professional setting, or their combinations. Specifically, the proposed framework suggests that an individual professional's decision to accept a technology can be explained or predicted by factors pertaining to the individual context, the technological context, and the implementation context.

The individual context comprises essential characteristics of individual users; in our case, health-care professionals. Conceivably, physicians, as a group, may exhibit characteristics subtly different from those of end users and managers in ordinary business organizations. Within the individual context, the investigative focuses are to identify essential individual characteristics and to assess their plausible effects on technology acceptance. The technological context concentrates on important characteristics of the technology under investigation. From both cognitive and behavioral perspectives, perceived characteristics may be more important or relevant than "objective" characteristics. Understandably, various user groups may view a technology differently and are likely to concentrate their technology evaluation using different criteria. In this connection, the analysis focus of the technological context is to identify important perceived technology attributes, together with assessments of their potential effects on individual technology acceptance. The implementation context refers to the specific professional environment where the investigated technology acceptance takes place. A common telemedicine implementation context is the clinical setting where individual physicians provide care and services to patients and collaborate with their peers in service delivery and patient management. Hence, analysis of the implementation context needs to concentrate on important characteristics of the underlying organizational and task-performance setting that may affect physicians' technology acceptance decision-making.

Interestingly, the proposed framework differs from previous research in two areas. First, the framework does not include the management context, which has been considered by several prior studies [28, 30] to be fundamental in individual technology acceptance/adoption. The rationale for not including the management context is theoretically justifiable and pragmatically adequate. As Mintzberg [36, p. 192] comments, the power of a professional office is to emphasize authority of a professional nature—that is, the power of expertise. Individual physicians not only control their own work but also seek collective control of the administrative and managerial decisions that may affect them, particularly in their practices and services. Consequently, administrators and managers are likely to exert some, but limited, influences on physicians' technology acceptance decisions. The described expertise-oriented control or power, in turn, contributes to professional dominance of physicians over managers, which has been examined and supported empirically (such as [32]). Second, the framework departs from conclusions offered by Goodhue and Thompson [21], who advocate the importance of the task context. As we define it here, the implementation context in effect partially subsumes the task context as discussed by Goodhue and Thompson [21]. The nonroutineness component, which they found to be the most significant issue, can be viewed as part of the compatibility factor included in our implementation framework, which, at the same time, embraces other factors (such as, peer influence) that may have considerable effects on individual technology acceptance in a professional setting.

Within the framework, plausible causal relationships may exist between or among the described constituent contexts. The implementation context conceivably encompasses both the individual and the technological contexts and thus might exert influences on them. Similarly, the individual context may affect or be affected by the technological context. Although effects at the broad-context level might be fairly invariant, the particular factors characterizing the respective contexts and their probable causal relationships and effects on technology acceptance may be specific with respect to the technology and the professional category. Hence, the proposed framework can provide a useful departure point toward a systematic examination of technology acceptance by individual professionals. Nevertheless, investigations of the technology acceptance of interest should proceed in light of a particular technology, a particular professional (user) category, or both.

The current study examines the acceptance of telemedicine technology by individual physicians. Based on the discussed framework as well as findings from relevant prior research and our field observations, a research model specifically tailored to the technology acceptance under investigation is developed. As shown in Figure 1, our research model includes six factors that denote characteristics essential to the constituent contexts included in the framework. The following section describes our research model in detail.

Research Model

The Individual Context

TYPICALLY, A PHYSICIAN PROVIDES SPECIALIZED SERVICES in a professional manner and has relatively high autonomy over the use of a technology (such as, telemedicine)

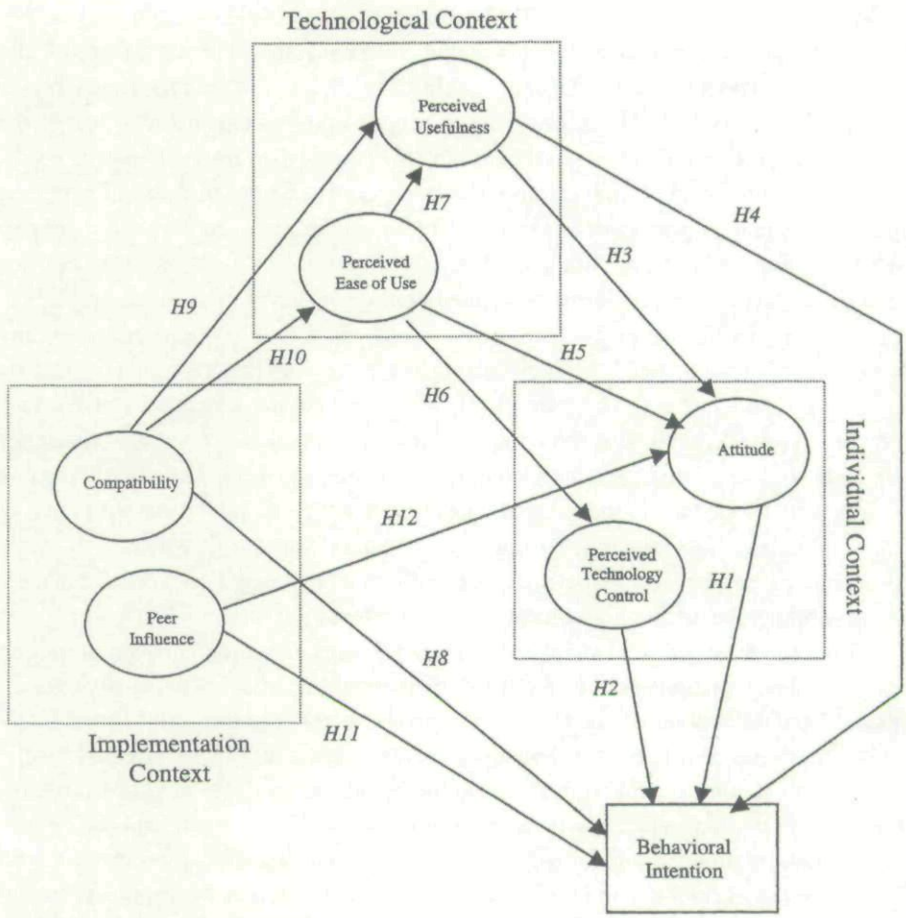

Figure 1. The Research Model

in their practice. In many cases, administrative managers have only limited influences on a physician's decision to include a technology in their practice. The described autonomy increases the likelihood or importance of voluntary technology use, making technology acceptance increasingly dependent on individual perception and evaluation. In this connection, individual attitude and perceived control of the use of a technology may become essential determinants of the individual context.

In this study, attitude refers to a physician's positive or negative evaluative affect about using telemedicine technology. Through professional networks, medical literature and other sources, physicians have become aware of telemedicine technology and have accumulated varying levels of knowledge about the technology's clinical values/utilities and potential risks, which jointly form individuals' salient beliefs about probable effects or results of using the technology. Through continual information acquisition and integration, a physician develops their attitude toward using telemedicine technology, which over time may result in a positive or negative intention to include the technology in the practice. Accordingly, we hypothesized the following:

H1: A physician's attitude toward using telemedicine technology will positively affect the intensity of their behavioral intention to accept the technology.

The level of technology acceptance exhibited by a physician may also be influenced by their perceived technology control, which broadly refers to a physician's perceived ability to use telemedicine technology. Prevalent dimensions of perceived technology control include acquisition of the procedural knowledge and resources necessary for mastering the technology under discussion. Perceived technology control is closely related but does not precisely correspond with the perceived behavioral control (in TPB), which refers to an individual's perceptions of the presence or absence of requisite resources or opportunities necessary for performing a behavior [2]. In general, perceived behavioral control encompasses various facilitating conditions pertaining to both the organization and the technology and thus has a broader scope than perceived technology control. The discussed professional dominance of physicians observed in many health-care organizations is likely to enhance their control of facilitating conditions not directly related to technology. As a result, the notion of perceived technology control arguably is more relevant and specific than perceived behavioral control in investigations of physicians' technology acceptance decisions. Accordingly, we tested the following hypothesis:

H2: The level of technology control as perceived by a physician will positively affect the intensity of their behavioral intention to accept the technology.

The Technological Context

Investigations of important technology characteristics and their influences on individual acceptance/adoption have been fairly extensive. Instead of examining key technology characteristics from a primary or objectively technical perspective, we evaluated the technology's usefulness and ease of use perceived by the physicians. Moore and Benbasat [37] have suggested that perceived rather than objective technology attributes are more relevant to an individual's technology acceptance decision-making. To be accepted, telemedicine technology, at a minimum, needs to be seen by a physician as encompassing sufficient utilities for supporting or facilitating their core patient care services. Perceived usefulness is important to a physician's technology acceptance decision-making and may influence the ultimate decision directly as well as indirectly (such as, via the strengthening of a positive attitude toward accepting the technology). Both the direct and indirect effects are included in the model, which postulates that perceived usefulness has positive influences on attitude and behavioral intention. Accordingly, the following hypotheses were tested:

H3: The level of usefulness of telemedicine technology as perceived by a physician will positively affect their attitude toward accepting the technology.

H4: The level of usefulness of telemedicine technology as perceived by a physician will positively affect the intensity of their behavioral intention to accept the technology.

At the same time, physicians, as a group, are not particularly known for technology competence, perhaps in part because of the historically nondominant role of IT in physicians' medical education and clinical training. Despite their relatively high intellectual/mental capacities and learning capabilities, some physicians may not be highly familiar with IT, which, coupled with their busy schedules, is likely to result in considerably diminished acceptance of technologies that are complicated or difficult to use. As Mintzberg comments [36], the knowledge base of a health-care organization is sophisticated but its technical system, the set of technologies and instruments used to apply the knowledge base, is not (nor can be) complicated. In this vein, having a positive perception of a technology's ease of use may contribute to the development and solidification of a positive attitude toward using the technology, which, in turn, can strengthen the intention for accepting the technology. Similarly, favorable perceived ease of use may contribute to an increased level of perceived technology control. Moreover, perceived ease of use may positively affect perceived usefulness. As reported by several previous studies [8, 26, 27, 28], individual users have exhibited a tendency toward considering a technology to be more useful when it is perceived as easy to use. Based on the above discussion, the following hypotheses were tested:

H5: The level of ease of use of telemedicine technology as perceived by a physician will positively affect their attitude toward accepting the technology.

H6: The level of ease of use of telemedicine technology as perceived by a physician will positively affect their perceived technology control.

H7: The level of ease of use of telemedicine technology as perceived by a physician will positively affect their perceived usefulness of the technology.

The Implementation Context

The implementation context refers to the particular professional setting where the target technology is to be implemented. Results from prior research suggest that the implementation environment for a particular technology may be assessed from two perspectives: compatibility of the adopting technology with respect to current work practices and peer influences.

In this study, compatibility refers to the degree to which the use of telemedicine technology is perceived by a physician to be consistent with their practice style or preference.[4] Broadly, the practice of a physician follows a pigeonhole process, consisting of contingency categorization and standard program selection and execution phases (with probable iterations). When providing care or services to a patient, a physician first categorizes the patient's need (such as, contingency or diagnosis), then selects appropriate standard programs (such as, treatments or protocols) from a repertoire, and subsequently executes them. Over time, a physician becomes increasingly accustomed to and deeply entrenched in a particular practice style or preference and thus is unlikely to accept a technology unless it is perceived to be compatible with that practice style or preference. Following this reasoning, the more telemedicine technology is perceived by a physician to be compatible with their current work practice, the higher the likelihood the physician would accept the technology. The described effect is supported by previous research findings that conclude that physicians resist changing their traditional long-standing practice patterns when their organizations implement information systems that interfere with their routines [4]. Accordingly, we tested the following hypothesis:

> *H8: The degree of compatibility of telemedicine technology as perceived by a physician will positively affect the intensity of their behavioral intention to accept the technology.*

Compatibility may also influence behavioral intention indirectly, such as, through its effects on perceived usefulness or perceived ease of use. Physicians are likely to "recognize" the usefulness of a technology when it is considered to be compatible with their work practices. At the same time, physicians are likely to consider a technology as easy to use when its inclusion in their practices does not require major changes in care procedures or service processes. Significant incompatibility necessitates major process/service changes, which often require considerable learning and unlearning on the part of physicians who consequently are likely to find the technology not easy to use. Accordingly, we tested the following hypotheses:

> *H9: The degree of compatibility of telemedicine technology as perceived by a physician will positively affect their perceived usefulness of the technology.*

> *H10: The degree of compatibility of telemedicine technology as perceived by a physician will positively affect their perceived ease of use of the technology.*

Peer influence, on the other hand, refers to a physician's perception of relevant colleagues' opinions on their use of telemedicine technology. Peer influence is closely related to subjective norms but has an explicitly defined focus; that is, the relevant others are professional peers. Results from prior research suggest that physicians have exhibited considerable dominance over managers and patients, making the opinions of their professional peers alone increasingly relevant and important. Such opinions may in part become the basis for normative beliefs to which a physician may want or is willing to conform to varying degrees. In a nutshell, the specialization and professionalism in the practice of medicine may partially explain the respect or value that a physician places on the opinions or suggestions of their peers. Consciously or unconsciously, a physician may align or adjust their behavior or behavioral intention, including that for using telemedicine technology, to such opinions and suggestions. Therefore, we hypothesized the following:

> *H11: The level of peer influence as perceived by a physician will positively affect the intensity of their behavioral intention to accept the technology.*

Peer influence may also affect a physician's technology acceptance decision indirectly, such as, through attitude formulation or solidification. Typically, coordination and adjustment among individual physicians are primarily based on specialized knowledge and professional opinions, which may make peer influences increasingly potent and relevant in patient care and service decision-making. Furthermore, opinions of peers may become normative beliefs of varying intensity levels, which, in turn, can exert considerable conformance pressure on a physician. As a result, the physician may include peers' opinions when forming their attitude toward using telemedicine technology. Accordingly, the following hypothesis was tested:

H12: The level of peer influence as perceived by a physician will positively affect their attitude toward accepting the technology.

Research Approach

THE FOCUS OF THIS STUDY IS INDIVIDUAL PHYSICIANS' INTENTIONS to use telemedicine technology. Similar to many other behaviors, technology acceptance can be measured by actual technology use as well as by intention to use [37, 47]. In this study, intention was chosen over actual usage to measure technology acceptance. The decision was practical and theoretically justifiable. At the time of the study, actual use of telemedicine technology in Hong Kong, our study site, was not widespread. However, many organizations had shown considerable interest in telemedicine-assisted services and some had committed to or actually implemented the technology. The constraint of primitive (but growing) technology use prohibited us from using actual technology use to generate results with statistical significance. Nevertheless, use of behavioral intention to approximate or project actual behavior is justifiable from both research and managerial perspectives. On the research side, use of intention to explain or predict actual behavior has an established theoretical foundation and has accumulated sufficiently strong empirical support [44, 54]. Mathieson [34] has examined and supported the use of behavioral intention as a viable dependent variable, commenting that, given the strong causal link between intention and actual behavior, the fact that behavior was not directly assessed is not a serious limitation (p. 186). Several recent technology acceptance/adoption studies have also used intention to use as their dependent variable (such as [30, 54]). From the technology management perspective, measuring and analyzing the target intention of physicians allow an essential and timely examination of their technology acceptance decision-making at a time when a fast-growing number of health-care organizations are seriously contemplating adopting and implementing telemedicine technology.

Research Design and Data Collection Procedures

Measures

The question items used to operationalize the constructs included in the research model were primarily adapted from the literature, with changes in wording appropriate for telemedicine technology and the targeted health-care context. Specifically, items on perceived usefulness and perceived ease of use were adapted from Davis

[17]; items on compatibility, peer influence, perceived technology control, and attitude came from Taylor and Todd [49]; and items on behavioral intention originated from Davis [17] and Taylor and Todd [49]. All items were measured using a seven-point Likert-type scale, with "strongly agree" at one end and "strongly disagree" at the other. To ensure desired balance and randomness in the questionnaire, one-half of the included items were negated and all of the questions were randomly arranged so as to reduce a potential ceiling (or floor) effect that may induce monotonous responses to multiple question items designed to measure a particular construct.

Subjects

The study targeted physicians practicing at public tertiary hospitals in Hong Kong and included ten different medical specialty areas, namely, internal medicine, geriatrics, pediatrics, obstetrics and gynecology, surgery, emergency care, intensive care, psychiatry, pathology, and radiology. Choice of the these specialties was made primarily on the basis of accessibility and the likelihood of the respective specialists' involvement with telemedicine-enabled services as well as becoming technology adopters in the near future. As a group, physicians at these hospitals have considerable interorganizational service needs, including rendering second or specialist's opinions, assessing patient transfer or admission requests, participating in and often taking the lead in team-based patient management, and responding to medical emergencies that require special care [31, 32]. These service needs and others may be effectively supported by telemedicine technology. The specific medical specialty areas included in the study were selected based on their frequent appearances in prior telemedicine research/practice and the satisfactory results documented in these studies [39].

Pretests

Use of question items developed or validated in previous studies does not automatically guarantee satisfactory validity and reliability. As Straub [45] comments, the validity of an instrument may not be persistent across different technologies and user groups. A series of pretests were therefore conducted to examine and validate the survey instrument, ensuring that it encompassed content validity and reliability at an acceptable level. First, three physicians from different specialty areas and public tertiary hospitals were asked to evaluate the content validity of the instrument. Using a card sorting method discussed by Moore and Benbasat [37], question items included in the instrument were printed on 6 cm × 8 cm index cards. The cards were shuffled randomly and presented to the physicians who were asked to sort them into appropriate categories (that is, theoretical constructs) individually. The card sorting evaluation results were satisfactory, as the physicians were able to categorize the presented question items with an accuracy rate of 85 percent or higher.

Following the satisfactory content validity evaluation, the instrument was then examined in several areas, including questionnaire wording and design, reliability, and consistency. Interviews with another 15 physicians from various specialty areas and hospitals were conducted to solicit input and suggestions on the wording and sequence of the question items in the instrument. Based on the feedback, some modifications were made, including the removal of several question items. For instance, an item adapted from Davis [17], "using telemedicine technology can enable me to complete patient care more quickly," was subsequently removed because many physicians, in spite of their heavy clinical duties and busy schedules, contend that the primary purpose of using telemedicine technology was patient care and service improvement. They considered service efficiency enhancement (measured by service turnaround time) to be secondary. The resulting instrument was considered more communicative and appropriate for telemedicine technology and the targeted health-care context.

Another 35 physicians were asked to evaluate the survey instrument in a subsequent pretest study. Based on responses from this pretest group, the instrument's reliability was evaluated using Cronbach's alpha. Judged by the resulting alpha values (ranging from 0.62 to 0.85), the instrument appeared to exhibit an acceptable level of reliability. The question items used to measure the respective constructs of the research model are listed in Appendix A, together with their original sources. Physicians who participated in the card sorting evaluation, instrument assessment interviews, or the pretest study were excluded from the subsequent formal study.

Study Administration

Before sending out the questionnaires, an encounter letter, which explained the research purpose and ensured the necessary confidentiality, was sent to the chiefs of service of the targeted clinical departments or divisions at eight public tertiary hospitals in Hong Kong. Personal visits and telephone calls were then made to these chiefs of service to provide detailed study information and solicit their support. Out of the 70 clinical departments or divisions contacted, 41 agreed to take part in the study, showing a 59 percent participation rate.

With the assistance of these chiefs of service, questionnaire packets were delivered to individual physicians who practiced in the participating clinical departments or divisions. Each packet contained a cover letter stating the study purpose and the intended data usage and management, endorsement letters from the Hong Kong Telemedicine Association and the HA, the questionnaire, and selected representative telemedicine references that included pictorial illustrations and technology overviews appropriate for the respective medical specialty areas under investigation. The particular references and technology overview materials had been reviewed and recommended by many physicians participating in the pretests. In addition, the instrument included a working definition of telemedicine to anchor responses from individual physicians. Immediately after the questionnaire distribution, a letter soliciting internal promotion of the study was faxed to the participating chiefs of service. Physicians were asked to return the completed questionnaire to their department secretaries, from whom the questionnaires were collected at a later time.

Of the 1,728 questionnaires distributed, 421 were returned. Thirteen of them had incomplete responses and were excluded from subsequent data analysis. Thus, effective respondents totaled 408, showing a 23.6 percent response rate. Among the respondents, 75 percent were male and approximately 80 percent had received their medical education in Hong Kong. On average, the responding physicians were 35 years old and had 9.5 years of post-internship clinical experience in their respective specialty areas. Approximately 44 percent of the responding physicians (that is, 178) specialized in services that required considerable (direct) patient contact (such as, internal medicine, obstetrics and gynecology, and pediatrics), 32 percent (that is, 130) specialized in services primarily based on medical/radiological imaging (such as, radiology and pathology), and the remaining were from specialty areas that usually involved patient contact and medical/radiological imaging (such as, accident and emergency, intensive care and surgery).

Data Analysis and Results

Reliability

Using the collected responses, the reliability and convergent and discriminant validity of the factors contained in the research model were evaluated. Reliability was assessed using Cronbach's alpha. As summarized in Table 1, most of the investigated factors exhibited an alpha value close to or greater than 0.70, suggesting a reliability exceeding the common acceptable level [38]. Adapted from Taylor and Todd [49], the scale of perceived technology control showed an alpha value of 0.55, which is lower (but not by much) than 0.60, a reliability threshold commonly considered as satisfactory in exploratory investigations.

Convergent and Discriminant Validity

Factor analysis was conducted to examine the measurement's convergent and discriminant validity. Specifically, we used iterated principal axis analysis with a promax rotation rather than principal components factor analysis with a varimax rotation, primarily because of the likelihood that the factors would be correlated [22, 33]. Generally, convergent validity is considered to be satisfactorily established when measurement items load highly on their respective constructs. Table 2 summarizes the factor analysis results. As shown, seven factors were obtained with eigenvalues greater than 1.0 and most item loadings were satisfactorily high (that is, greater than 0.50) on the respective constructs. The only exception was the item loading for perceived technology control, which was below but close to 0.50. The convergent validity is therefore considered reasonably satisfactory. A primary criterion for discriminant validity evaluation is each item's loading being higher on its respective construct than that on any other constructs. As shown in Table 2, the results also suggested that the included measures exhibited satisfactory discriminant validity.

Harmon's one-factor test was performed to evaluate the potential effects of common method variance [40]. The one-factor test restricts the items presumably designated to measure different constructs to a single-factor analysis. When the dominance

Table 1. Summary of Measurement Scales

Construct	Mean	Standard deviation	Reliability
Attitude (ATT)			
ATT1	2.83	1.03	
ATT2	2.96	1.16	0.69
ATT3	2.59	1.15	
Perceived technology control (PTC)			
PTC1	2.85	1.08	
PTC2	3.94	1.34	0.55
PTC3	2.88	1.39	
PTC4	3.85	1.31	
Perceived usefulness (PU)			
PU1	2.80	1.17	
PU2	3.04	1.20	0.86
PU3	3.30	1.22	
PU4	2.93	1.16	
Perceived ease of use (PEOU)			
PEOU1	3.02	1.30	
PEOU2	3.46	1.16	0.77
PEOU3	3.11	1.60	
PEOU4	3.21	1.18	
Compatibility (COM)			
COM1	3.46	1.30	
COM2	3.23	1.24	0.83
COM3	3.28	1.16	
Peer influence (PIN)			
PIN1	3.66	1.07	
PIN2	3.30	1.03	0.75
PIN3	3.36	1.07	
Behavioral intention (BI)			
BI1	3.47	1.28	
BI2	2.98	1.26	0.86
BI3	3.23	1.26	

of a single factor is observed, these items are considered to be related because of the use of a common method, in our case, the self-reporting method. Our analysis result shows that the single most dominant factor accounted for only 14 percent of the total variance, suggesting that the underlying common method variance may not have been significant.

Nonresponse Biases

Nonresponse is a potential source of bias in survey research and therefore needs to be properly addressed. In this study, potential nonresponse biases were examined by comparing early and late respondents in several key areas, including demographic

Table 2. Results of the Factor Analysis

Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
PU1	**0.87**	−0.04	−0.11	−0.03	0.13	0.24	0.04
PU2	**0.82**	−0.05	−0.02	0.00	0.09	0.29	−0.01
PU4	**0.80**	−0.02	−0.03	−0.06	0.09	0.26	0.03
PU3	**0.64**	−0.00	−0.10	−0.03	0.07	0.26	0.00
COM3	−0.05	**0.91**	0.00	−0.01	0.07	0.22	0.16
COM1	−0.04	**0.77**	0.01	−0.01	0.07	0.18	0.26
COM2	−0.00	**0.71**	0.02	0.00	0.07	0.22	0.16
PEOU4	−0.10	0.08	**0.77**	0.00	0.05	−0.02	−0.05
PEOU1	−0.03	0.02	**0.75**	0.08	0.01	0.04	0.14
PEOU3	−0.09	−0.04	**0.66**	0.01	−0.03	−0.01	0.08
PEOU2	−0.00	−0.00	**0.53**	0.03	0.09	0.04	−0.13
PIN3	−0.09	−0.01	0.04	**0.90**	0.00	−0.04	0.13
PIN2	−0.00	0.03	−0.00	**0.77**	−0.01	−0.02	0.08
PIN1	0.02	−0.04	0.06	**0.50**	−0.02	0.05	0.09
BI3	0.11	0.09	0.05	−0.03	**0.80**	0.09	0.09
BI1	0.06	0.05	−0.01	−0.00	**0.77**	0.16	−0.01
BI2	0.10	0.04	0.06	0.01	**0.63**	0.14	0.07
ATT1	0.19	0.22	−0.01	0.02	0.12	**0.79**	0.10
ATT2	0.23	0.16	0.01	−0.02	0.14	**0.61**	0.07
ATT3	0.27	0.14	0.04	−0.03	0.11	**0.57**	0.01
PTC1	0.03	0.17	0.03	0.09	0.07	0.12	**0.61**
PTC4	−0.00	0.11	0.04	0.03	0.02	0.00	**0.46**
PTC3	0.07	0.17	−0.09	0.03	0.03	−0.03	**0.46**
PTC2	0.01	0.06	0.04	0.12	0.04	0.10	**0.43**
Eigenvalue	3.34	2.69	2.36	2.09	1.92	1.57	1.33
Percent of variance	13.90	11.23	9.85	8.70	8.00	6.56	5.55

characteristics and responses to question items for the respective constructs included in the research model. Early respondents were physicians who completed and returned the questionnaire within the initial two-week response window, whereas late respondents were those who returned the questionnaire in the subsequent extended response periods. The distribution of early and late respondents in the study is fairy balanced, showing a ratio of 203 to 205.

No significant differences in both age and post-internship clinical experience were observed between these two groups, which were also largely comparable in their respective distribution in such areas as medical specialty, gender, and country of medical training. Findings from the comparative analysis of the responses (to question items for the respective constructs) from early and late respondents also suggested insignificant differences between these groups (Table 3). Together, the prominent compatibility in important demographic characteristics and the high similarity in responses to the respective question items suggested that the threat of nonresponse bias may have been reduced.

Model Testing Results

The research model was evaluated using LISREL. Using the sample covariance matrix (see Appendix B), the overall fit and the explanatory power of the research model were examined. In addition, we also evaluated the significance and the relative strength of the individual paths specified by the model.

The overall goodness-of-fit was examined using the following six common model fit measures: chi-square/degree of freedom, 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 included because of its inherent problem with sample size [23]. As summarized in Table 4, the research model exhibited a fairly good fit with the data collected from the responding physicians, as suggested by the investigated goodness-of-fit indices exceeding or approaching their respective acceptance levels commonly suggested by previous research [9].

The explanatory power of the research model was evaluated by examining the portion of variance explained. The analysis results suggested that the model was able to explain 43 percent of the variance in physicians' intention to use telemedicine technology (Figure 2). Furthermore, 37 percent of the observed variance in attitude appeared to have been explained by perceived usefulness, of which 57 percent of the variance was accounted for by compatibility.

The significance and the relative strength of individual links specified by the research model were also evaluated. As summarized in Table 5, six out of the 12 postulated paths were of statistical significance: one at the 0.05 significance level, two at the 0.01 level, another at the 0.001 level, and the remaining two at the 0.0001 level. Specifically, the paths from attitude and perceived technology control to behavioral intention were both significant, as suggested by the p-value being less than 0.01. Perceived usefulness appeared to be a significant determinant of both attitude and

Table 3. Analysis of Nonresponse Biases

Construct	Early respondents (N = 203)	Late respondents (N = 205)	Significance
Attitude (ATT)	2.78	2.79	$t = 0.093$, $p = 0.926$
Perceived technology control (PTC)	3.44	3.32	$t = 1.436$, $p = 0.152$
Perceived usefulness (PU)	3.12	3.05	$t = 0.695$, $p = 0.488$
Perceived ease of use (PEOU)	3.24	3.18	$t = 0.653$, $p = 0.515$
Compatibility (COM)	3.36	3.29	$t = 0.590$, $p = 0.555$
Peer influence (PIN)	3.38	3.28	$t = 1.190$, $p = 0.234$
Behavioral intention (BI)	3.16	3.07	$t = 0.904$, $p = 0.366$

Table 4. Overall Fits of the Research Model

Fit index	Recommended value	Observed value
Chi-square/degree of freedom	≤3.0	2.01
GFI	≥0.90	0.91
AGFI	≥0.80	0.89
NNFI	≥0.90	0.92
CFI	≥0.90	0.93
SRMSR	≤0.10	0.07

behavioral intention, at the 0.001 and the 0.0001 significance levels, respectively. Perceived ease of use exhibited a significant influence on perceived technology control (at the 0.05 significance level), but its effects on perceived usefulness and attitude were not statistically significant. Compatibility appeared to be a highly significant determinant of perceived usefulness (with a *p*-value of less than 0.0001), but its effect on perceived ease of use was statistically insignificant. Furthermore, peer influence did not exhibit significant influences on either attitude or behavioral intention.

The strength of each individual path was assessed in terms of the standardized path coefficient, ranging from –1 to +1. Table 6 summarizes both direct and indirect effects of the respective factors. Compared with other factors, perceived usefulness exhibited the strongest direct effect as well as total effect on a physician's intention to use telemedicine technology. The direct effect of attitude on intention was weaker than that of perceived usefulness but stronger than that of perceived technology control. Interestingly, the indirect effect of compatibility on intention, through its strong direct effect on perceived usefulness, was greater than the direct effect of attitude on intention.

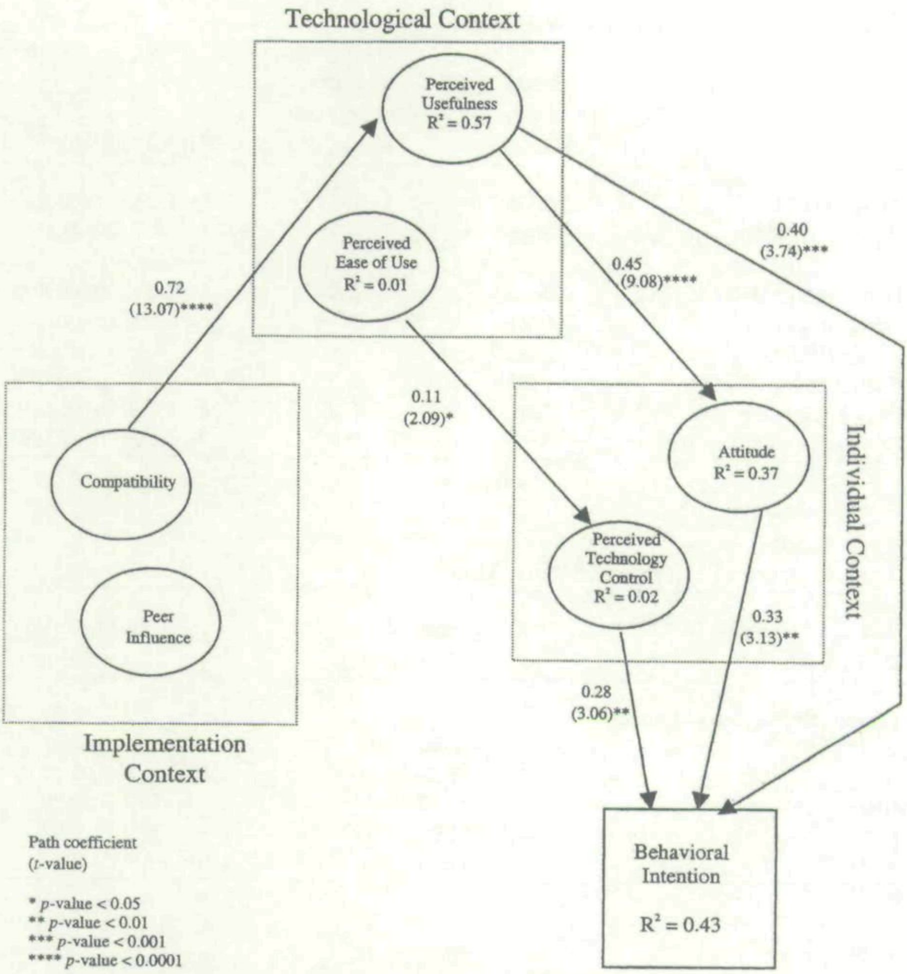

Figure 2. Results of the Model Test (only significant paths are shown)

Discussion

THIS STUDY EXAMINED TELEMEDICINE TECHNOLOGY acceptance by physicians in a health-care context. Based on a proposed generic framework for technology acceptance by individual professionals, a research model for the investigated technology acceptance was developed and empirically examined, using responses from more than 400 physicians practicing in public tertiary hospitals in Hong Kong. Results obtained from the structural equation modeling analysis suggested that the research model exhibited a satisfactory overall fit to the collected data and was capable of providing a reasonable explanation of individual physicians' acceptance of telemedicine technology (that is, 43 percent). One-half of the causal links (that is, hypotheses) specified by the model were supported at different statistical significance levels and exhibited relative strength of various levels. A detailed discussion of each individual path follows.

Table 5. Significance of Individual Paths

Path	Path coefficient (t-value)		Hypothesis
ATT -> BI	**0.33**	**(3.13)****	**H1**
PTC -> BI	**0.28**	**(3.06)****	**H2**
PU -> BI	**0.40**	**(3.74)*****	**H4**
COM -> BI	0.03	(0.34)	H8
PIN -> BI	–0.09	(–0.94)	H11
PU -> ATT	**0.45**	**(9.08)******	**H3**
PEOU -> ATT	0.07	(1.57)	H5
PIN -> ATT	0.08	(0.99)	H12
PEOU -> PTC	**0.11**	**(2.09)***	**H6**
COM -> PU	**0.72**	**(13.07)******	**H9**
PEOU -> PU	0.02	(0.51)	H7
COM -> PEOU	0.08	(1.41)	H10

Notes: * p-value < 0.05; ** p-value < 0.01; *** p-value < 0.001; **** p-value < 0.0001.

Table 6. Strengths of Individual Factors

Effect on behavioral intention	Effect size
Direct effect	
ATT	0.33
PTC	0.28
PU	0.40
COM	0.03
PIN	–0.09
Indirect effect	
PU	0.15
PEOU	0.05
COM	0.39
PIN	0.02
Total effect	
ATT	0.33
PTC	0.28
PU	0.55
PEOU	0.05
COM	0.40
PIN	–0.07

Significance of Perceived Usefulness

Results of the study showed that perceived usefulness may be the single most significant determinant of physicians' acceptance of telemedicine technology. In addition to its strong direct effect on intention, perceived usefulness also exhibited a considerable indirect effect on intention, via attitude. The observed significant effect of perceived usefulness on technology acceptance may reflect and therefore reinforce a physician's tendency of taking a tool-oriented view of technology. Several implications can be derived from this finding. First, physicians, as a group, appear to be fairly pragmatic in their technology evaluation and selection by focusing on practical utility rather than on technological novelty. Thus, physicians are likely to accept a technology when it provides considerable or desirable utilities to their practices. In this light, telemedicine technology, to be accepted, needs to demonstrate satisfactorily sufficient utilities for supporting or enabling patient care and other services offered by physicians. Second, the observed considerable indirect effects of perceived usefulness on technology acceptance suggest the importance of attitude management through communication and articulation of favorable perceived usefulness. Hence, health-care organizations may need to consider formulating strategies that foster technology acceptance through favorable attitude cultivation and solidification. Communicating the technology's usefulness is important, particularly in situations where perceived usefulness alone cannot (directly) bring about a desired level of technology acceptance. Third, the observed strong dependence of the acceptance decision on perceived usefulness represents an interesting area where individual professionals may subtly differ from common users in technology acceptance decision-making.

Insignificance of Perceived Ease of Use

Perceived ease of use, in the investigated professional context, appeared to have limited effects on attitude. This finding differs from results reported in several prior technology acceptance/adoption studies that had focused on common user groups (such as [30]). The observed limited effects may be partially explained by the working environment of individual health-care professionals. By and large, physicians have access to reasonably strong staff support from nurses and technologists in service rendering and equipment/technology operations. The described staff support might, in turn, make ease of use an issue of less importance as perceived by physicians. Another plausible explanation may be the higher-than-average learning capability or intellectual capacity of physicians who often have developed effective learning heuristics or methods that may enable them to master a new technology with less extensive training than is necessary for other user groups, thus reducing the effect of perceived ease of use on attitude. Furthermore, perceived ease of use appeared to have no significant effects on perceived usefulness, suggesting that physicians are not likely to consider a technology to be useful simply because it is easy to use.

Davidson and Chismar [15, 16] examined technology adoption in hospitals and suggested that physicians had exhibited reluctance or resistance when the inclusion of a technology would reduce their professional authority. In this connection, a physician may feel halfhearted about, or even develop a negative attitude toward, accepting a technology when the physician needs to depend significantly on the nursing or other staff to use the technology. Our observations in various clinical settings in Hong Kong suggested that many physicians operated telemedicine technology directly, if not singly, and thus their inclusion of the technology, regardless of its complexity or difficulty, is not likely to diminish profoundly their professional authority in telemedicine-enabled service encounters. From the perspective of professional authority as discussed by Davidson and Chismar [15, 16], perceived ease of use may have limited impacts on both positive and negative attitudes.

Perceived ease of use, on the other hand, appeared to have a significant effect on perceived technology control. This finding suggests that a physician's perceived control in the use of telemedicine technology may improve when the technology is considered to be easy to use. Understandably, the perceived level of technology control in operating a technology decreases when the technology is considered to not be difficult or complicated to use.

Significance of Compatibility

Compatibility was found to be a significant determinant of perceived usefulness but not of perceived ease of use. Judged by its 0.72 path coefficient at a 0.001 significance level, the link from compatibility to perceived usefulness is the most significant among all the causal paths investigated. As summarized in Table 6, the indirect effect of compatibility on intention is comparable to the direct effect of perceived usefulness on intention and is greater than the direct effect of attitude on intention. This finding may imply another interesting characteristic of technology acceptance by individual professionals. The compatibility of a technology with an individual professional's current work practice may be a critical antecedent to perceived usefulness, which may play an important, although indirect, role in developing a positive attitude toward using the technology. The observed significance of compatibility on perceived usefulness is consistent with and therefore reinforces the findings from a recent study by Davidson and Chismar [15, 16], who concluded that technology adoption in hospitals was heavily influenced by doctors' perceptions about their professional role and status in the provision of services. A physician's use of a technology highly compatible to their current practice style/preference is not likely to introduce unfavorable changes in their perceived role in the provision of services and, at the same time, may contribute to increased usefulness of the technology as perceived by the physician. On the other hand, significant changes in long-standing practice patterns necessitated by the inclusion of an incompatible technology may diminish the technology's usefulness as perceived by individual physicians. As noted by Chircu and Kauffman [10], required changes in existing routines and norms might reduce the potential value of a newly introduced information technology.

Compatibility appeared to have no significant direct influences on intention but it exhibited a significant indirect effect on intention via perceived usefulness, alone or in conjunction with attitude. This finding suggests that compatibility may represent a necessary but insufficient condition for technology acceptance by individual professionals. In our case, a physician is not likely to exhibit a strong intention to use telemedicine technology simply because of its fit with their practice pattern or style. The observed effects of compatibility highlight the importance of the technology-practice fit. At a minimum, an organization needs to evaluate carefully a technology's fit with the current practices of its affiliated individual professionals before committing resources to technology acquisition and implementation. In situations where an organization has to implement a technology not highly compatible with the existing practices of its member professionals, the management needs to evaluate primary sources or areas of incompatibility and develop strategies to bring about a gradual and smoothing transition toward the necessary changes.

Significance of Attitude

Attitude showed a significant direct effect on intention and, in effect, appeared to be the second most important determinant of intention, next to perceived usefulness. This finding is largely consistent with results from many previous studies (such as [30]) that have examined the relationship between attitude and behavioral intention. Thus, forming a positive attitude toward accepting the technology under discussion is crucial for both professional and common users. In the case of telemedicine technology, the observed effects of attitude on intention suggests that health-care organizations should be attentive to individual attitudes and should proactively cultivate and solidify favorable individual attitudes toward technology acceptance.

Insignificance of Peer Influence

Peer influence appeared to have no significant effects on either attitude or intention, a finding inconsistent with the conclusions by Taylor and Todd [49] and Harrison et al. [22], respectively. Several factors might have been at the root of the observed insignificance of peer influence, including professional autonomy and the characteristics of urban-based medical practice as well as the early telemedicine development in Hong Kong. Typically, physicians provide specialized services in a professional manner and often have relatively high autonomy over their practices, including the use of a technology. Administrative management or even peers may affect a physician's technology acceptance decision but perhaps not to an extent of profound significance. The described autonomy, in turn, increases the importance of voluntary technology use that may largely be determined by individual attitude and technology evaluation rather than by influences from managers and peers alike. Specialized training and high autonomy encourage independent thinking and decision-making, which may jointly contribute to a physician's tendency to respect but place relatively less weight on peers' opinions in attitude development or making a technology acceptance decision. Together, the described specialization and autonomy and the resulting independence may partially explain the observed insignificant peer influence on attitude and intention.

The urban characteristics of Hong Kong and its early telemedicine development might also have explained the observed insignificance of peer influence on attitude and intention. Hong Kong is highly dense in population, making geographic dispersion or disparity an issue of less concern in health service access than in more rural areas. In general, telemedicine is considered attractive in regions characterized by great geographical dispersion or disparity in service access. The limited graphical dispersion in Hong Kong may, to some degree, have diminished the perceived value of telemedicine by some physicians who subsequently may not be easily be convinced by their peers' opinions or recommendations on the technology use. Moreover, judging from the established programs and the provided services, the overall telemedicine development in Hong Kong was largely in an early stage at the time of the study. Conceivably, some physicians may not have interacted with or had convenient access to peers sufficiently experienced in the evaluation and use of telemedicine technology. The described lack of experts in the field might, in turn, have caused some physicians to place less weight on peer opinions when making their technology acceptance decisions. Regardless of its sources, the observed limited effects of peer influence on technology acceptance single out another potential area where professionals and common users might subtly differ in their respective technology acceptance decision-making.

Significance of Perceived Technology Control

Perceived technology control appeared to have a significant effect on intention, but to a lesser extent than attitude and perceived usefulness did. A plausible explanation for this observed modest effect is that, as supported by our observations of various clinical settings, the technology operations in general may not be particularly complicated, especially when considering physicians' learning capability and staff support from nurses and technologists alike. This finding is consistent with results obtained from several previous technology acceptance/adoption studies involving common user groups, including Mathieson [34] and Taylor and Todd [48, 49]. As explained by Taylor and Todd [48], "inexperienced users tend to discount control information in the formation of intentions, relying instead primarily on PU (perceived usefulness)" (p. 566). Together, the relatively uncomplicated technology operations, reasonable staff support, and relatively high intellectual/learning capacity may have decreased the effects of perceived technology control on technology acceptance by individual physicians.

A Revised Framework for Technology Acceptance by Individual Professionals

RESULTS FROM THIS STUDY HAVE SHED LIGHT on the potential areas where the initially proposed framework can be modified. In particular, a hierarchical structure appears to have emerged. As shown in Figure 3, the framework may be considered to be of a "three-layer" structure, in which the individual context and the implementation context are situated in the inner and outer layers, respectively, with the technological context in the middle. The "core" of the hierarchy is the individual professional's technology acceptance, the exact level or intensity of which is determined jointly by these three layers, directly and indirectly. Each layer has a direct effect on technology acceptance as well as on the level beneath it. As such, effects on technology acceptance may be cascaded through consecutive layers that represent the respective constituent contexts.

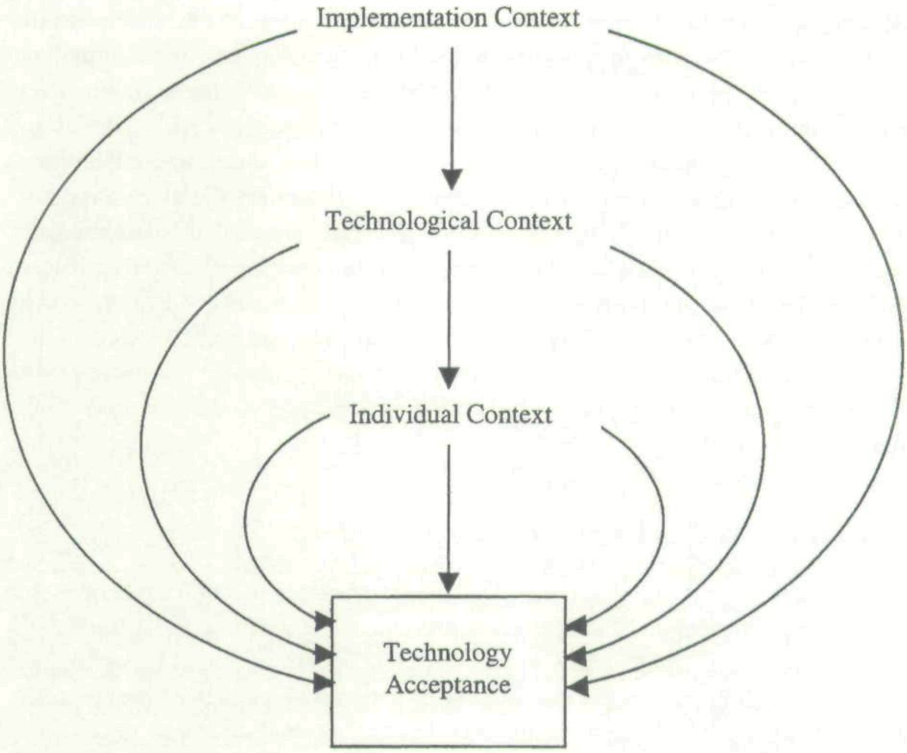

Figure 3. A Revised Framework for Technology Acceptance by Individual Professionals

According to this revised framework, the main thrusts of an individual professional's decision to accept or not to accept a technology would be their attitudinal assessment of accepting the technology and the evaluation of their control over the technology use. Together these factors characterize the individual context and directly affect individual technology acceptance. At the same time, these factors, to a great extent, are directly influenced by other sets of factors that define the technological context and the implementation context. Specifically, essential characteristics of the technological context that may include perceived usefulness and perceived ease of use, which directly affect the individual context in terms of attitudinal assessment and perceived technology control. Meanwhile, perceived usefulness and perceived ease of use of the technology may be directly affected by such factors as compatibility and peer influence, which together characterize the implementation context. Broadly, compatibility (or technology-practice fit) may be conceived as a technology's compliance and congruence with the underlying service rendering process or procedure and thus can be measured accordingly.

Through the described layered structure that depicts plausible sources and directions of influences between or among constituent contexts, the revised framework may contribute to an improved conceptualization of technology acceptance by individual professionals. In particular, the revised framework allows desired categorization of important technology acceptance factors at an adequate abstraction level and, at the same time, provides a systematic analysis of the general influence structure (or patterns) among the constituent contexts that are fundamental to the technology acceptance of interest. The resultant conceptualization of technology acceptance is established at the context level and thus the specific factors essential to each context and their effects may be specific to the technology, the professional (user), or both. Compared with prior studies, which generally follow a (nonstructural) factor-modeling approach, the revised layered-structure framework arguably may provide additional insights about technology acceptance by individual professionals.

Limitations

THIS EXPLORATORY STUDY HAS SEVERAL LIMITATIONS. Our research results suggest potential areas where professional and common users might subtly differ in their respective technology acceptance decision-making. However, discussed findings and implications nevertheless are based on a single-study design that examined a particular technology and involved a specific user group, professionally and geographically. Therefore, caution needs to be taken when extrapolating or generalizing these research results to other technologies, professional groups, or environments. Similarly, this study did not address the potential individual diversity within a professional group. Physicians are not homogenous in their technology acceptance decision-making, which may vary with specialty areas, the service sector (such as, public or private), core services, and clinical experience levels. Although singling out the potential differences between professional and common users, this study did not investigate the described individual variations in the targeted specialty areas, which understandably encompass some shared characteristics.

The revised framework has the potential to provide additional insights about technology acceptance by individual professionals but it is limited in its structural delineation and general impact patterns. For instance, the individual context may affect the technological content. Several previous studies (such as [12, 13]) have reported that self-efficacy, an individual-level factor, has significant effects on technology acceptance in a variety of ways, including indirect influences on perceived usefulness (in the technological context). Similarly, our research results did not support the direct impact of the implementation context on individual technology acceptance (as suggested by the revised framework). Nevertheless, the revised framework represents a reasonable starting point for continued investigations required for further framework refinement.

The working definition of telemedicine technology used in this study admittedly is rather broad in scope and thus conceivably supports an array of health-care services or applications. The definition was chosen because of the exploratory nature of the investigation, which intended to provide a point for departure for continued research on IT acceptance by individual professionals. Hence, a broad definition with respect to both technology and medical specialty area was considered more appropriate and desirable than a definition highly specific to a particular technology or medical specialty. This broad definition allowed the establishment of a fundamental understanding of the technology acceptance of interest and, at the same time, enabled the generation of preliminary findings from which continued research may proceed. To reduce potentially adverse variations in physicians' arbitrary characterization of technology, we provided a working definition of telemedicine technology in the instrument and included in each survey packet selected references and brochures on commonly available telemedicine technologies adequate for the respective specialty areas under investigation. Both the working definition and the selected references were intended to anchor responses from the individual physicians. At the time of the study, most physicians at Hong Kong's tertiary hospitals by and large had possessed considerable knowledge about telemedicine technology and its common or promising applications in their respective areas, mainly through medical literature, technology vendors, professional contacts, and various workshops and seminars. On an experimental or trial basis, many physicians in effect had accumulated hands-on experiences with the technology made available by vendors or research groups from universities [31, 32].

The operationalization of the constructs included in the research model is another source of limitation. Measures were primarily adapted from relevant prior research and therefore might introduce limitations in investigating the probable technology acceptance differences between professional and common users. The relatively low reliability values of some scales, perceived technology control in particular, might suggest the potential limitation of the measure's applicability in situations that involve different user groups or contexts. This limitation reinforces the importance of instrument reevaluation discussed by Straub [45] and highlights the need for new instrument development, or at least modifications to existing ones, to ensure a desired fit with the targeted context, the user group, or both.

Another limitation is the research model's explanatory utility, which is reasonable but not satisfactory. Compared with those reported by prior studies on IT acceptance/adoption, the R-square obtained in our study is relatively low. Specifically, in the studies conducted by Mathieson [34] and Taylor and Todd [49], R-squares were reported in the range of 0.5 and 0.7 for the respective research models (that is, TAM and TPB). In our case, the R-square for behavioral intention was 0.43, suggesting that there was a plausible omission of factors important to acceptance of telemedicine technology by individual physicians.

Last but not least, the current study is also limited in the timing of and method for data collection. Our data were cross-sectional—that is, the responses were collected from physicians at a particular point in time. The acceptance or assessment of telemedicine technology by a physician understandably may be time-variant, adjusted, or modified as the physician gains additional knowledge about or experience with the technology. In effect, results from prior research (such as [25, 47]) have suggested that the relative influence of key technology acceptance factors may change as users become more experienced with the technology. Hence, our findings and discussion indeed represent a snapshot of the technology acceptance phenomenon of interest and their generalization requires cautious interpretation. Furthermore, the responses were collected from the physicians using the self-report technique, a technique about which IS researchers still have concerns of varying degrees [11, 46], in spite of its use in many previous technology acceptance/adoption studies. For example, Thompson et al. [51] suggest that both objective and subjective measures should be employed and that the correspondence (or the lack of it) between them should be examined regardless of which factor is used as the dependent variable. Similarly, Szajna [47] suggests that additional behavior-oriented measures (such as, choice behavior) should be used. Melone [35], on the other hand, has examined the use of the user-reported, self-assessment data collection technique and has suggested that this approach is appropriate in situations where perceptual measures can cope with real-world constraints more effectively than objective measures can. Although the intention focus of our study inherently made the self-report approach natural and appealing, choice of this data collection method nevertheless represents a limitation of the study.

Conclusions

As various IT applications that support the work and services of professionals continue to be rapidly developed, adopted, and implemented, examinations of factors critical to technology acceptance by individual professionals become increasingly important. Of particular interest and importance to IS research is whether or not these factors might differ from those reported by prior IT acceptance/adoption studies that have focused on end users, knowledge workers, and business managers. Drawn from a theoretical premise established through a synthesis of relevant literature, a generic framework for technology acceptance by professionals was proposed to provide a foundation upon which a research model for explaining or predicting physicians' acceptance of telemedicine technology was developed. Using responses collected from more than 400 physicians practicing in public tertiary hospitals in Hong Kong, the research model was empirically examined in terms of its overall fit and explanatory power as well as the individual causal relationships it specified. Several implications for both research and practice have emerged and are discussed as follows.

Implications for Research

Findings of the study shed light on several areas where professional and common users might subtly differ in their respective technology acceptance decision-making. Specifically, professionals appear to be fairly pragmatic, focusing on the usefulness of a technology rather than on its ease of use. Individual professionals appear to have strong concerns about technology-practice compatibility, tend to place less emphasis on their control of technology use, and appear to attach a limited weight to suggestions or opinions from peers. Conducted in a professional setting that includes genuine target users and routine tasks, the current study responds to the need to extend IT acceptance/adoption research into the study of health care, a service sector that has experienced increasing IT investment and penetration [41] and has the merits of generating research results applicable to real-world technology management practices.

Results from the study also provide evidence of the usefulness or appropriateness of the proposed (and revised) framework for technology acceptance by individual professionals. Based on a multidimensional approach, the framework may provide a holistic view of technology acceptance that takes place in a professional organization as well as a foundation upon which particular research models can be developed or modified. Additional empirical support is needed to validate the resulting framework that broadly depicts a layered structure and general impact patterns at the constituent context level.

In addition, this study brings an international perspective to IT acceptance/adoption research. Rosenzweig [43] challenges the presumption of conceptual equivalence across language and cultural barriers in management research. To be useful, research results must be validated in a larger context, providing additional empirical support of research findings that subsequently can be generalized or considered applicable in different cultural settings. In this connection, this study represents an effort toward validating previous research results in a different context by examining the acceptance of telemedicine technology by physicians in Hong Kong. Conceivably, physicians from a different culture may exhibit interesting differences in technology acceptance decision-making. For example, physicians practicing in a culture typically characterized by relatively high uncertainty avoidance [24] might consider compatibility or perceived ease of use of telemedicine technology differently from those operating in a culture exhibiting more uncertainty tolerance. Similarly, the particular technology acceptance decision factors essential to physicians and their exact effects might subtly vary with such cultural dimensions as power distance and individualism.

The discussed limitations and implications suggest several important future research directions. First, continued effort is needed to validate and improve the research model, regarding both its theoretical basis and empirical applicability. For instance, identification of additional variables to explain the observed behavioral intention variations not accounted for by the current model is essential. Plausible theoretical premises might include computer self-efficacy [12, 13, 53], participation and involvement in the design process [50], prior usage and experience [48, 50], and user characteristics [28]. Analysis of important task characteristics may be interesting, particularly when anchored on the notion of task-technology fit that focuses on the efficacy of technology with respect to an individual's task performance [15, 19]. In addition, the perceived net value of a transition as described in the Technology Transition Model by Briggs et al. [7] might shed additional light on potential model enhancement directions. When properly combined with those already included in the research model, these factors may provide a fuller explanation of the technology acceptance of interest. Inclusion of new variables into the research model may result in additional relationships that need to be examined theoretically and empirically.

Second, further investigations are needed to reexamine the validity of our framework in order to expand its generalizability or applicability. This is particularly important, given the constraints or limited empirical support of the revised framework in structural delineation and general impact patterns. Along this vein, identifying the factors of concern in the literature and examining their plausible effects are a logical starting point, allowing a broad assessment of the framework's layered structure and its general impact patterns. Longitudinal investigations that involve different contexts defined by technology or professional (user) groups may further augment the framework's empirical validity and generalizability. At the same time, investigating technology acceptance longitudinally also allows an examination of potential changes in the relative importance and influence pattern of key acceptance factors over time. Together, results anticipated from these promising research directions would conceivably advance our understanding of the underlying causality between or among the important decision variables and, at the same time, extend and validate comparative technology acceptance differences between individual professionals and end users and business managers commonly found in the business world.

Implications for Telemedicine Management Practice

From a managerial standpoint, the findings of this study reveal the importance of attitude cultivation and solidification in managing technology acceptance by individual professionals. In this light, dissemination and communication of positive perceptions of the technology's usefulness are crucial. The technology's ease of use may be important to individual professionals' technology acceptance decisions but perhaps to a reduced extent. Along with the decision to adopt a particular technology, the management should consider placing a high priority on demonstrating the usefulness of the technology and communicating to the affiliated professionals its support of and utility in rendering individual services and work performance. In the case of telemedicine, initial information sessions and hands-on training programs should concentrate on demonstrations of the technology's support, facilitation, and improvement of an individual physicians' patient care and services rather than detailed operational procedures or sequences. A fundamental objective of the initial information and training sessions is to cultivate positive attitudes among physicians who subsequently may develop or exhibit increasing intention to include the technology routinely in their services.

The observed effects of compatibility on perceived usefulness also have important implications for telemedicine technology development, selection, and implementation. The prevalent systems approach in contemporary medicine, together with rigorous and demanding clinical training, inevitably calls for and subsequently results in the development of specific practice routines to which individual physicians become accustomed over time. Major changes to these routines are difficult and are rarely well received by physicians. To promote the acceptance of telemedicine technology, management needs to devise strategies that establish and communicate assurance of the technology's compatibility with the physicians' current practices rather than requiring a major overhaul of existing service routines or styles.

Finally, the observed insignificance of peer influence might suggest that physicians are not easily susceptible to influence from others, an interesting manifestation of a characteristic natural to their underlying professionalism. However, the limited effects of peer influence should be duly considered by taking account of the early stage of telemedicine development in Hong Kong, where few health-care professionals have sufficiently strong experiences with and expertise in telemedicine to exert convincing influence to disseminate and foster desirable technology acceptance among their peers. Nevertheless, when promoting telemedicine technology, management may need to focus on highlighting and demonstrating the technology's usefulness rather than heavily depend on persuasion by those with limited experiences with the technology.

Acknowledgments: The authors thank the anonymous reviewers for their constructive comments and suggestions that were valuable to the revisions of the manuscript. 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).

Notes

1. Although acknowledging the differentiation between "professionals" and "common users" is largely coarse rather than dichotomous, we took a fairly conventional and selective view of "professionals." By professionals, we mean those who have received highly specialized education/training in the traditionally recognized professional categories (such as, medicine and law), obtained commonly and legally required professional qualifications (such as, M.D. and J.D.), and are currently practicing their profession in a professional manner and setting. The authors thank an anonymous reviewer for providing valuable comments on differentiating professional and common user groups.

2. Loosely, physicians in this study refer to all certified and licensed medical doctors, which include general practitioners, specialists, and subspecialists. Thus, we did not distinguish primary care physicians and specialists (or subspecialists), the latter of which, in effect, were the targeted physicians in the study.

3. Although greatly congruent with those commonly referenced as defined by the World Health Organization, the American Medical Association, the European Commission, Bashshur [5, 6] and Darkins and Cary [14], this definition admittedly is broad and embraces service applications of interest or relevance to physicians from different special areas. Our choice of a broad rather than a focused definition is supported by the existing telemedicine literature and, at the same time, allows an examination of technology acceptance by physicians across an array of medical specialty areas. To anchor the subjects' responses, our survey packet included references on representative or common types of telemedicine technology applicable or relevant to the services of target physicians from each special area examined. Exemplar technologies included two-way real-time teleconferencing systems and medical image transmission/display systems with multimedia capability, about which the physicians were knowledgeable or experienced. Hence, results of the study are probably more generalizable as well as more relevant to the management of telemedicine technology by health-care organizations than would be otherwise.

4. The compatibility literature suggests that compatibility may consist of two components: congruence with existing practices and consistency with the values or norms of potential adopters [52]. In our research model, we decided to represent these two components using two distinct constructs that jointly depict the implementation context. Specifically, we used compatibility to denote the level of congruence with the existing work practices. On the other hand, peer influence was used to reflect the other component, which, we argue, is the major source of influence on shared values or norms in individual physicians. Ramiller [42] has provided an in-depth discussion of the concept of compatibility.

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Appendix A. 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.	[49]
	ATT2	• Using telemedicine technology in patient care and management is unpleasant.	
	ATT3	• Using telemedicine technology is beneficial to my patient care and management.	
Perceived technology control (PTC)	PTC1	• I would have the ability to use telemedicine technology in my patient care and management.	
	PTC2	• Using telemedicine technology would be entirely within my control.	[49]
	PTC3	• I would not have the knowledge to make use of telemedicine technology in my patient care and management.	
	PTC4	• 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.	[17]
	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.	[17]
	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.	
Compatibility (COM)	COM1	• Using telemedicine technology fits with the way I work.	[49]
	COM2	• Using telemedicine technology does not fit with my practice preferences.	
	COM3	• Using telemedicine technology fits with my service needs.	
Peer influence (PIN)	PIN1	• People who influence my clinical behavior think that I should use telemedicine technology.	[49]
	PIN2	• People who are important to my health-care services think that I should not use telemedicine technology.	
	PIN3	• People who are important in assessing my patient care and management think that I should not use telemedicine technology.	
Behavioral intention (BI)	BI1	• I intend to use telemedicine technology for patient care as often as needed.	[17, 49]
	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.	

Appendix B. Covariance Matrix

	PU1	PU2	PU3	PU4	PEOU1	PEOU2	PEOU3	PEOU4	ATT1	ATT2	ATT3
PU1	1.36										
PU2	1.01	1.45									
PU3	0.78	0.71	1.49								
PU4	0.93	0.88	0.78	1.34							
PEOU1	0.15	0.16	0.12	0.10	1.68						
PEOU2	0.08	0.05	–0.05	0.02	0.51	1.34					
PEOU3	0.05	0.19	0.05	0.01	1.12	0.54	2.55				
PEOU4	0.01	0.00	0.06	0.01	0.84	0.68	0.82	1.38			
ATT1	0.36	0.37	0.41	0.42	0.20	–0.01	0.13	0.13	1.06		
ATT2	0.47	0.47	0.33	0.45	0.16	–0.04	0.10	0.09	0.58	1.34	
ATT3	0.46	0.45	0.39	0.37	0.11	–0.03	0.06	–0.03	0.51	0.48	1.31
BI1	0.61	0.55	0.61	0.58	0.17	0.07	0.06	0.06	0.44	0.38	0.32
BI2	0.51	0.51	0.40	0.50	0.15	0.06	0.08	–0.01	0.27	0.44	0.31
BI3	0.55	0.53	0.61	0.56	0.11	0.02	–0.10	0.10	0.35	0.33	0.48
PTC1	0.26	0.27	0.36	0.25	0.09	0.02	0.06	0.12	0.21	0.16	0.18
PTC2	0.18	0.16	0.34	0.15	0.04	0.00	–0.02	–0.05	0.10	0.07	0.10
PTC3	0.38	0.34	0.18	0.28	0.18	0.07	0.15	0.11	0.05	0.06	0.07
PTC4	0.16	0.19	0.15	0.20	0.14	0.03	0.19	0.07	0.13	0.17	0.17
PIN1	0.01	–0.03	0.08	–0.03	0.04	0.14	0.04	0.06	0.04	0.00	0.11
PIN2	0.00	0.02	0.01	–0.02	0.07	0.12	0.04	0.09	0.04	0.04	0.05
PIN3	–0.08	–0.04	–0.01	–0.10	0.06	0.17	0.03	0.15	0.03	–0.02	0.05
COM1	0.69	0.73	0.89	0.75	0.06	0.01	0.10	0.05	0.30	0.32	0.36
COM2	0.62	0.64	0.66	0.80	0.01	–0.03	0.00	0.09	0.30	0.38	0.28
COM3	0.63	0.64	0.80	0.76	0.09	0.07	0.12	0.08	0.37	0.32	0.33

	BI1	BI2	BI3	PTC1	PTC2	PTC3	PTC4	PIN1	PIN2	PIN3	COM1	COM2	COM3
PU1													
PU2													
PU3													
PU4													
PEOU1													
PEOU2													
PEOU3													
PEOU4													
ATT1													
ATT2													
ATT3													
BI1	1.65												
BI2	0.75	1.58											
BI3	1.00	0.80	1.60										
PTC1	0.31	0.30	0.35	1.17									
PTC2	0.36	0.18	0.21	0.31	1.79								
PTC3	0.14	0.27	0.28	0.52	0.30	1.93							
PTC4	0.10	0.19	0.12	0.36	0.56	0.19	1.72						
PIN1	–0.02	–0.03	0.09	0.06	0.04	0.15	0.01	1.05					
PIN2	–0.02	–0.01	0.05	0.12	0.04	0.08	0.11	0.41	1.06				
PIN3	–0.08	–0.10	–0.01	0.02	0.03	0.04	0.11	0.50	0.77	1.14			
COM1	0.49	0.41	0.51	0.29	0.30	0.40	0.24	0.02	0.07	0.04	1.68		
COM2	0.37	0.43	0.43	0.26	0.16	0.33	0.13	–0.02	0.10	0.02	0.88	1.54	
COM3	0.56	0.33	0.47	0.28	0.14	0.32	0.09	0.02	0.03	0.00	1.05	0.94	1.35