


Factors influencing telemedicine adoption among physicians in the Malaysian healthcare system: A revisit

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Abstract

Background: The Malaysian healthcare system is under strain due to an aging population, the rising prevalence of chronic diseases, and heavy workloads among physicians. As costs and requirements continue to rise, telemedicine is critical for bridging gaps in supply and demand. However, there are limited studies on telemedicine adoption among Malaysian physicians. Furthermore, the existing literature on telemedicine adoption does not contain a comprehensive framework that integrates the multidimensional social influence, and technological, clinical, and individual factors.

Objective: This research investigates the adoption of telemedicine among Malaysian physicians. It draws from the Technology Acceptance Model (TAM) and Kelman's Social Influence Theory.

Methods: A survey was conducted among 230 participants in hospitals located in Kuala Lumpur and Selangor. The data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM).

Results: The study identified crucial factors influencing telemedicine adoption, including informational influences, rewards, perceived ease of use, and usefulness. Meanwhile, the Importance-performance Map Analysis (IPMA) identified perceived ease of use as the most important factor for physicians, but the highest performance was patient's records.

Conclusions: The proposed integrated model enhances the understanding of telemedicine adoption and highlights the differential effects of individual, technological, clinical, and multidimensional social influence factors from the physicians' perspective. The findings can guide future studies and influence implementation strategies for telemedicine promotion in the Malaysian healthcare context. Hospitals should prioritize user-friendly technology and information provision, while telemedicine providers should enhance the accessibility of patient records to facilitate telemedicine adoption. Policymakers should consider supporting training programs that will boost physicians' confidence in effectively utilizing telemedicine.

Keywords

Telemedicine, physicians, adoption, TAM, quantitative, social influence theory, Malaysia, behavior

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Introduction

Healthcare is more than just about individual well-being; it is a fundamental pillar upon which the prosperity and stability of nations are built.¹ According to the World Health Organization,² global spending on healthcare has doubled in real terms over the past two decades, reaching USD 9 trillion and 10.8% of GDP in 2020 (an increase from 8.5% in 2000). Demographic shifts, which include aging populations and an increased prevalence of chronic

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diseases, place an ever-growing burden on healthcare systems. In this era of burgeoning healthcare needs and costs, telemedicine has garnered significant global attention. As a transformative paradigm in healthcare, telemedicine is not only a driver of expenses but also a solution for the widening the gap between healthcare supply and demand.

Telemedicine is the utilization of telecommunications technology and digital platforms for healthcare providers to remotely provide medical services, consultation, diagnosis, treatment, and health-related information to patients. This innovative approach transcends geographical boundaries by allowing patients to conveniently access healthcare services regardless of their physical location.³ However, telemedicine adoption within the global healthcare community was relatively sluggish before the COVID-19 pandemic. This is primarily because it was considered an alternative rather than a mainstream method of healthcare delivery.⁴ However, healthcare provision underwent significant changes in 2021, and telemedicine usage skyrocketed by a remarkable sixfold compared to 2019, particularly in larger healthcare settings such as community health centers and academic medical institutions.⁵

In Malaysia, the use of telemedicine in the healthcare system is gaining increasing importance. Based on data from the Department of Statistics Malaysia, the country's aging population is expected to surpass 15% of the total population by 2030; this will cause an influx of older individuals and those with chronic diseases into the primary care system. This trend will significantly burden the healthcare system in Malaysia.⁶ The Malaysian healthcare system has two tiers: a government-subsidized public sector and a fee-for-service private sector. The public sector offers comprehensive and affordable care through primary healthcare facilities linked to specialized hospitals, while the private sector caters to wealthier individuals who can afford higher fees. Even though Malaysia's mixed public-private healthcare system ensures tangible accessibility, its healthcare workforce does not adequately meet the rising healthcare demands of the country.⁷

According to the Ministry of Health Malaysia,⁸ there are currently 2.4 doctors per 1000 population in Malaysia. While this figure is higher than that of neighboring countries such as Thailand and Vietnam, it is lower than Singapore, Japan, and Australia. In primary care, the per capita density of physicians is 1.5 per 1000 population in urban areas and 1.1 per 1000 population in rural areas.⁹ This disparity, coupled with a substantial increase in patient visits in the public sector, has led to overloaded clinics that cause congestion and exceed physician capacity.^{6,9} In summary, the aging population, the increased prevalence of chronic diseases, and the heavy physician workload have placed a growing burden on Malaysia's healthcare systems. Telemedicine is a crucial solution that could bridge the widening gap between healthcare supply and demand amidst escalating healthcare needs and costs.¹⁰

Telemedicine has made significant strides in Malaysia, with the government launching its first telemedicine blueprint in 1997 as part of the Multimedia Super Corridor Project.¹¹ This initiative aimed to employ the use of telemedicine in the country's healthcare system. In 2019, Malaysia's Ministry of Health (MOH) launched a teleconsultation pilot using video consultation technologies at five public primary care clinics to enhance healthcare accessibility and alleviate congestion at these clinics.¹² In line with global trends, telemedicine use also increased during the COVID-19 pandemic. By the end of 2020, telemedicine services had expanded to cover 35 additional public primary care clinics, with many other clinics also proactively initiating teleconsultation in response to the crisis.¹¹ This growth was driven by the need to provide healthcare services while minimizing the risk of virus transmission and maximizing the potential to improve research, disease control, and clinical management.¹³

In recent years, there has been a noticeable trend of increasing global studies examining telemedicine adoption. Many of these studies commonly utilize technology acceptance models, such as TAM or Unified Theory of Acceptance and Use of Technology (UTAUT), to evaluate telemedicine adoption.^{14–21} Nevertheless, studies have criticized solely relying on the TAM and UTAUT models to explain technology adoption.^{22,23} For instance, researchers argue that the functional and utilitarian benefits proposed in TAM, such as perceived ease of use, do not sufficiently explain consumer technology acceptance.²⁴ In addition, recent studies like those by Cobelli et al.¹⁴ and Vidal-Silva et al.¹⁵ heavily emphasize compliance aspects of subjective norms within the UTAUT framework, but they overlook the critical process of identification and internalization aspects in social influence.²⁵ Thus, there is a call to expand the focus beyond mere compliance-based social influence, as this tends to diminish in impact over time with increased individual experience.

Despite the recent surge in telemedicine adoption studies, there remains a dearth of literature concerning telemedicine adoption from the physician's perspective, especially in developing Southeast Asian countries like Malaysia. Accordingly, Pereira et al. (2023) emphasized the need for future research to investigate telemedicine adoption from the perspective of physicians. While telemedicine can minimize contact with sick patients and reduce the transmission of microbes,²⁶ its increased and evolving use has raised challenges and limitations that can strain healthcare providers. Therefore, understanding the physician's perspective on telemedicine adoption is crucial, as the acceptance of telemedicine by physicians is a major barrier preventing its effective implementation in the healthcare system.^{13,27–30}

Therefore, the objective of this study is to investigate the adoption of telemedicine among doctors and physicians in

Malaysia by employing a combined approach of the Technology Acceptance Model³¹ and Kelman's Social Influence Theory.³² This dual-theory approach integrates the elements of successful technology adoption from TAM with the multidimensional social and clinical factors that could influence telemedicine adoption among physicians.²² By amalgamating these theories, the study aims to provide a comprehensive understanding of the factors that shape healthcare professionals' and physicians' perspectives on the proposed application of telemedicine. It also aims to offer a holistic view that acknowledges both technological feasibility and the human aspects of healthcare delivery. The study's findings will be essential in influencing telemedicine implementation in Malaysia, as it will aid the Ministry of Health's efforts in planning and driving increased adoption among physicians in Malaysian hospitals.

Literature review and theoretical background

It has become imperative for both scholars and practitioners to understand the factors influencing telemedicine adoption. To address this, researchers have proposed several theoretical models to elucidate the complexities of telemedicine acceptance. Commonly utilized models include UTAUT, UTAUT2, and TAM. For example, studies that have employed these models include those by Cobelli et al.,^{14,33} Klingberg et al.,³⁴ Vidal-Silva et al.,¹⁵ Kabra and Songroya,¹⁷ Schmitz et al.,³⁵ Ong et al.,¹ Arfi et al.,³⁶ Rajak and Shaw,³⁷ and Yamin and Alyoubi.³⁸ Other commonly adopted models include the behavioral model,³⁹ the theory of planned behavior,⁴⁰ the Unified Model of e-Government Adoption (UMEGA),⁴¹ the social cognitive theory,²¹ and the value-based adoption model.¹⁹ However, some studies^{20,42} have opted to use relevant variables from existing research without adhering to specific theories or models. Additionally, some studies have used combined models^{16,18,38,43} to predict telemedicine adoption, demonstrating the continued relevance and applicability of established theoretical frameworks in contemporary research. These approaches are aligned with Hubona and Geitz,⁴⁴ who observed that revising the existing models with external variables can influence the proportions of usage frequency and usage amount variances. The discussed papers above published from 2020 to 2024 are summarized in Table 1, which showcases the utilization of various popularly used adoption models.

It is worth noting that most telemedicine studies have been conducted using samples from China,^{15,18–21} with limited representation from Southeast Asian and developing countries, including Malaysia. In this study, we adopted the TAM³¹ and Kelman's Social Influence Theory.³² The following sections provide a detailed discussion of these two theories and their importance in filling the existing gaps.

Technology acceptance model (TAM)

Technology acceptance is described as an individual's psychological condition regarding his or her voluntary or intention to use a specific technology. Users' willingness to use technology is a critical component for the adoption of a new technology. Hence, researchers have introduced several models over the past decades to explore the characteristics of technology adoption among users.

Among the available theories, TAM and UTAUT are the most widely used models to predict individuals' technology acceptance behaviors in the health context.⁴⁵ Based on a systematic literature review by Garavand et al.,²⁷ most existing research on physicians' acceptance of telemedicine builds on TAM. TAM utilizes Perceived Usefulness (PUse) and Perceived Ease of Use (PEoU) to assess how technological aspects affect a user's intention to use technology.³¹ For instance, Lu et al.,¹⁸ Kamal et al.,²² and Alexandra et al.⁴⁶ adopted TAM to explain physicians' intentions to use telemedicine. TAM has been widely adopted because it is easily applied in different research settings. In addition, TAM has been recognized as the most powerful and frequently used model in predicting the use and acceptance of numerous technologies.

However, several studies have raised doubts about using solely TAM to identify technology acceptance.^{22,23} Researchers have argued that functional and utilitarian benefits, such as perceived ease of use, do not adequately explain consumer technology acceptance.²⁴ Hence, the original TAM has been used with additional variables or integrated with other models or theories to better reflect the users' technology adoption. For instance, several researchers have extended the original TAM with additional constructs such as perceived incentives, self-efficacy, accessibility of patients and medical records,⁴⁷ user profile, subjective norms, and physician security and confidentiality,⁴⁸ image, self-efficacy, voluntariness, compatibility, and anxiety,³⁴ and others. Besides, certain studies also integrated TAM with other theories, such as the Theory of Planned Behavior⁴⁹ and the Capabilities Approach.²³ A recent study by Lu et al.¹⁸ also integrated TAM with the Health Belief Model to investigate telemedicine adoption. Therefore, these revised or integrated frameworks can provide more thorough evidence of the adoption of technologies among physicians.

In developing countries like Malaysia, telemedicine is perceived as an effective and innovative alternative approach to healthcare services. In the telemedicine adoption context, TAM does not account for the potential impact of multidimensional social and clinical factors that can potentially influence physicians' telemedicine adoption.²² Hence, this study enhances TAM by integrating it with Kelman's Social Influence Theory to reflect the effects of the multidimensional social influence and technological factors that potentially influence physicians' telemedicine adoption. In addition, we added self-efficacy as the individual factors and clinical factors and included

Table 1. Summary of literature reports on telemedicine adoption from 2020–2024.

Item	Author	Year	Country	Theory/Model	Subject	Technology studied/ Platform	Findings (Factors influencing the adoption)	Limitation
1.	Cobelli et al. ¹⁴	2024	Italy	UTAUT, self-determination theory, and social identity theory.	Pharmacists	E-health	Performance expectancy, effort expectation and social influence.	- Self-selection bias. - Cultural differences.
2.	Vidal-Silva et al. ¹⁵	2024	Chili	UTAUT2	Not specific	Telemedicine	Performance expectancy, social influence, and price value	- Data was collected from individual who have internet access (Not patient/users/physician)
3.	Lu et al. ¹⁸	2024	China	TAM & Health Belief Model	General population	Telemedicine	Perceived usefulness, trust, social influence, economic benefits, and perceived severity.	- The samples are from a certain region, and psychological, cultural, and economic differences between regions may lead to different results.
4.	Cobelli et al. ³³	2023	Itali	Market-orientation paradigm & UTAUT New predictor: Market orientation	Pharmacists	Telemedicine	Performance expectancy, effort expectancy and facilitating conditions.	- Data collected from specific type of pharmacists and Italian pharmacists only. - Data collection during peak of COVID-19 pandemic.
5.	Upadhyay et al. ⁴¹	2023	India	Unified model of e-government adoption (JMEGA) New predictor: perceived severity, self-efficacy, and political trust	Consumer	E-government telemedicine service	Attitude, political trust and facilitating conditions.	- Online data collection only.
6.	Pereira et al. ¹⁶	2023	Portugal	Diffusion of innovation theory, UTAUT, health belief model, and concerns for information privacy framework	Young people in two institutes of higher education	Video consultations	Attitude, performance expectancy, and COVID-19.	- Selected samples (young people) are not representative enough.

(continued)

Table 1. Continued.

Item	Author	Year	Country	Theory/Model	Subject	Technology studied/ Platform	Findings (Factors influencing the adoption)	Limitation
7.	Kim & Han ³⁹	2023	Korea	Behavioral model	Older adults	Telemedicine & healthcare devices	Usefulness, information, cost saving, subjective health, and income.	- Functional and emotional values are neglected.
8.	Kabra & Songroya ¹⁷	2023	India	UTAUT Additional variables: Personal innovativeness	Medical practitioners	Telemedicine	Effort expectancy, facilitating conditions, performance expectancy, social influence, and personal innovativeness	- Further research from doctors' perspective is required.
9.	Xiong & Zuo ¹⁹	2023	China	Value-based adoption model	Frontline health care professionals	Mobile platform of medical and senior care (MPMSC)	Outcome expectations, perceived mobility, perceived effort, and privacy concerns predict perceived value. Perceive value and legal concern affect intention to adopt.	- Did not study factors in-depth. - This study investigated at the individual level only. Organizational level related factors are neglected.
10.	Yuen et al. ⁴³	2023	Singapore	Health Belief Model, Perceived Value Theory, and the Self-Determination Theory	Residents in Singapore who has used telehealth services	Telehealth	Perceived threat, cues to action, and perceived relatedness directly affect perceived value, while self-efficacy, perceived relatedness, and perceived autonomy have a direct impact on emotion. Perceived value of telehealth services has a direct and indirect positive influence on intention to adopt telehealth services through emotions.	- The study conducted in Singapore only which commonly viewed as a tech-savvy population. - This study is inclined toward users' psychological aspects, external factors are neglected.
11.	Schmitz et al. ³⁵	2022	Spain	UTAUT2 New predictor: perceived security and perceived product advantage	Patient	Telemedicine	Performance expectancy, hedonic motivation, perceived security, and perceived product advantage.	- Partial of the constructs from UTAUT are tested.

(continued)

Table 1. Continued.

Item	Author	Year	Country	Theory/Model	Subject	Technology studied/ Platform	Findings (Factors influencing the adoption)	Limitation
12.	Ma et al. ²⁰	2022	China	None	Health care professionals	Telemedicine	Short service duration, convenience of the operating system, cost subsidy incentive and the promotion of professional titles.	- The scope of research needs to be further expanded. - Geographical bias
13.	Ong et al. ¹	2022	Philippines	UTAUT2	Not specific	Telemedicine	Performance expectancy, effort expectancy, hedonic motivation, social influence, and resistance to use	- Data was collected from individual who have internet access (Not patient/users/physician) - Actual behavior not measured.
14.	Alexandra et al. ⁴⁶	2021	Indonesia	TAM	Individuals familiar with or having prior experience using a hospital's teleconsultation application.	Telemedicine	Contamination avoidance, safety, reliability, professionalism, PEoU, PUSe, and information quality	- Most of the respondents have age between 17 to 25 years old and live in the Greater Jakarta area which limit the result of this study.
15.	Cobelli et al. ⁴⁰	2021	Italy	Theory of planned behavior	Pharmacist	Telemedicine	Attitude and perceived behavioral control	- Convenient sampling was used.
16.	Rajak & Shaw ³⁷	2021	India	TAM Additional variables: social influence, technology anxiety, trust, perceived risk, perceived physical condition, resistance to change	Individuals were chosen based on their use of Android/smartphone devices and access to internet services on their phones.	mHealth (mobile health)	Social influence, perceived risk, resistance to change, physical conditions, and attitude.	- Respondents were new users of technology.
17.	Arfi et al. ³⁶	2021	France	UTAUT Additional variables: Perceived trust and perceived risk	Patient	E-health	Effort expectancy, social influence, facilitating conditions, and perceived trust (indirect- with perceived risk as mediator).	- This research was conducted among the French population only, and its size limits the generalization of the findings. - Data collection during pandemic.

(continued)

Table 1. Continued.

Item	Author	Year	Country	Theory/Model	Subject	Technology studied/ Platform	Findings (Factors influencing the adoption)	Limitation
18.	Ahmed et al. ⁴²	2021	Ethiopia	None	Health professionals	Telemedicine	Attitude, patient-physician relationship, and ease of use.	- No theoretical supports.
19.	Wu et al. ²¹	2021	China	Social cognitive theory	Patient	Telemedicine	Self-efficacy and trust	- Focuses on a region with high levels of telemedicine development only. - Most of the sample comprised middle-aged and old people, while fewer younger people were studied. - Did not consider other external variables
20.	Kamal et al. ²²	2020	Pakistan	TAM Additional variable: social influence, facilitating conditions, trust, privacy, perceived risk, technological anxiety and resistance towards technology	Patient	Telemedicine	PEoU, technological anxiety, social influence, PEoU, trust, facilitating conditions, perceived risk, and resistance to technology.	- Participant were mainly patients.
21.	Yamin & Alyoubi ³⁸	2020	Saudi	UTAUT, task technology fit model New predictor: Awareness and self-efficacy	Individual familiar with telemedicine applications, computers and mobile devices.	Telemedicine-wireless sensor network applications	Performance expectancy, social influence, effort expectancy, facilitating condition, task technology fit, awareness, and self-efficacy	- Results based on single country i.e., Saudi Arabia thus, results may differ when comparing with other countries. - Used online and non-random convenience sampling approach.

(continued)

Table 1. Continued.

Item	Author	Year	Country	Theory/Model	Subject	Technology studied/ Platform	Findings (Factors influencing the adoption)	Limitation
22.	Klingberg et al. ³⁴	2020	Tanzania	TAM; Additional variables: compatibility, image, voluntariness, self-efficacy, anxiety, social influence and facilitating conditions	Health providers	mHealth	Attitude. Compatibility and perceived ease of use affect PUse. Image, social influence, anxiety, perceived ease of use, and PUse affect attitude	- Study setting was limited to Dar Es Salaam, Tanzania, health workers' perceptions may differ from those working in rural area. - Small sample size.

accessibility of medical records and accessibility of patients to investigate the acceptance of telemedicine among physicians in detail.

Kelman's Social Influence Theory

Social influence plays a critical role in determining a person's attitudes, beliefs, and actions.³² Kelman's Social Influence Theory suggests three conceptually distinct approaches that influence a person's acceptance of an induced behavior. According to Kelman, social influences can be categorized into three different perspectives that influence a person's behavior, namely *compliance*, *identification*, and *internalization*.³² *Compliance* refers to an act of willingly adopting the induced behavior to attain rewards (or approval) while simultaneously avoiding penalties (or disapproval). The satisfaction derived from compliance is closely tied to the social effect of yielding the influence. *Identification* takes place when individuals engage in the suggested behavior to establish or maintain a mutually beneficial relationship with another person or a group. In this case, satisfaction arises from "the act of conforming itself" as it strengthens the desired relationship. *Internalization* occurs when individuals willingly accept, influence, and believe that the suggested behavior aligns with their values and conveys the thoughts and behaviors of others. They embrace the induced behavior because they recognize its consistency with their values, and this alignment with their values provides satisfaction.

Nevertheless, popular technology acceptance models, such as UTAUT, are focused on the *compliance* aspect of social influences. Most existing studies on telemedicine adoption, such as Cobelli et al.¹⁴ and Vidal-Silva et al.,¹⁵ have also focused on the compliance aspect of social influence in their studies. This argument has been underscored by Wang et al.,²⁵ who stated that the existing technology acceptance models like TPB, TAM2, and UTAUT often rely heavily on *subjective norms*. These norms primarily emphasized operationalizing the *compliance* aspect of social influence. The process of *identification* and *internalization* aspects of social influence as proposed by Kelman³² are ignored in the existing technological acceptance models.⁵⁰ Previous studies have highlighted the importance of investigating different social influence processes in technology adoption because the benefits of *identification* and *internalization* are likely to last longer, whereas compliance-based social influence effects may diminish with experience.²⁵ In line with this notion, Venkatesh and Morris⁵¹ also indicated that the diminishing impact of compliance-based social influence might be due to the users' tendency to internalize others' judgments and emphasize their own opinions. Hence, the single aspect of social influence (e.g., compliance) as proposed in well-known technology acceptance models may not accurately predict the users' technology adoption and behavior; several researchers have therefore made efforts to integrate the three perspectives of social influence processes.^{25,50}

The existing literature on telemedicine studies mostly builds on well-known technology acceptance models like TAM or UTAUT, which focus on a single aspect of social influences. Even though Malhotra and Galletta⁵⁰ and Wang et al.²⁵ have made progress by adopting Kelman’s Social Influence Theory to conceptualize the other social influence factors in the organizational setting, no consistent significance was revealed in these studies. Furthermore, while a recent study by Lu et al.⁵² investigated the multidimensional social influence on health-related technology adoption in China, this domain remains understudied in the context of telemedicine adoption, particularly in developing Southeast Asian countries such as Malaysia. As a result, this study proposes a more inclusive conceptualization of social influence to predict physician telemedicine adoption by developing hypotheses that integrate TAM with Kelman’s Social Influence Theory. This provides a comprehensive overview of how technological factors and multidimensional social influence affect physicians’ intention to use telemedicine in the Malaysian context. The following sections provide the hypothesis based on the constructs proposed.

Hypothesis development

Building on the TAM and Kelman’s Social Influence Theory, a research model was proposed to investigate physicians’ intentions to use telemedicine (Figure 1). As proposed in Kelman’s social influence theory, this study first assessed identification (image), internalization (informational influences), and compliance (rewards and sanctions) to reflect the multidimensional social influence that potentially influences telemedicine adoption. Then, the hypothesis for PEOU and PUse from the TAM is proposed. Following that, the hypothesis and discussions for individual factors (self-efficacy) and clinical factors

(accessibility of patients and medical records) are presented as the antecedents of PEOU and PUse of telemedicine. Table 2 provides an overview of the definitions for each construct.

Internalization

Internalization occurs when the process of deciding or adopting a behavior depends on how closely one’s values align with those of other members of the group. They may view the induced behavior as beneficial in resolving a problem or congruent with their needs.³² In other words, an individual will likely be involved in the desired behavior if the influential agent’s values are aligned with their value systems, and they perceive the respective behaviors to be intrinsically rewarding. Venkatesh and Davis⁵³ also confirmed that if a subordinate recommends that a given technology is useful, an individual will undergo internalization by believing that technology is useful. As a result, the person chooses to accept the external influence. *Informational influence* was therefore used to reflect that a person undergoes the process of internalizing external information.^{25,52}

Informational influence (Info). According to Deutsch and Gerard,⁵⁴ the influence to accept information obtained from other people as evidence of reality is known as *informational influence*. In the healthcare context, physicians regularly interact with colleagues and can observe colleagues’ behaviors.⁵⁵ With that, internalization is probably stimulated when physicians try to identify with their colleagues.⁵⁶ To properly interpret the situation’s reality and behavior, people could be influenced to adopt technology.⁵⁷ In line with this discussion, Lu et al.⁵² found informational influence to positively impact the physician’s acceptance of healthcare technology during

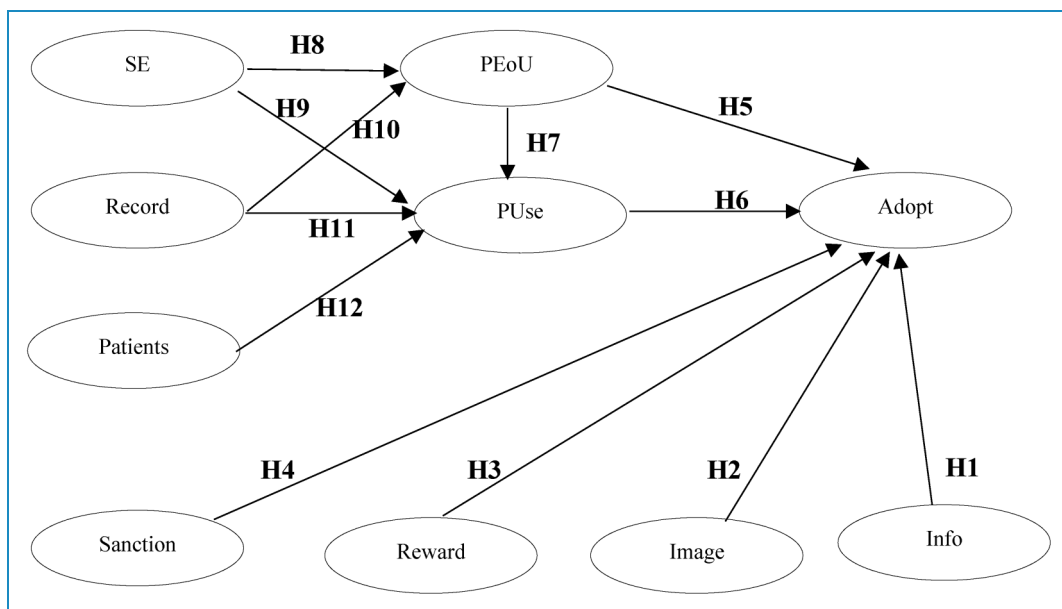


Figure 1. Research model.

Table 2. Definition of constructs.

Constructs	Definitions
Reward	The positive outcomes that an employee expects to receive when engaging in the desired behavior, such as bonuses, recognition from supervisors, and salary increases. ⁶⁹
Sanction	The withdrawal of positive consequences or application of negative consequences from supervisor such as coercion, punishment, or disapproval. ⁶⁹
Image	The extent to which the use of an innovation is perceived to increase a person's image or status in his or her social system. ⁶¹
Informational influences (Info)	The influence to accept information obtained from other people as evidence of reality. ⁵⁴
Self-efficacy (SE)	An individual's own perception of being able to perform an action or a task according to certain scenarios. ⁷⁹
Perceived usefulness (PUse)	The degree a physician perceives that telemedicine adoption will enhance the procedures and results of health treatment. ⁴⁷
Perceived ease of use (PEoU)	The degree a physician's perception of the ease of using telemedicine services. ⁴⁷
Accessibility of Patients (Patients)	The degree that physicians perceive that using telemedicine can enhance communication with underserved patients who reside far from medical institutions or hospitals. ⁴⁷
Accessibility of medical records (Record)	The extent to which physicians perceive that telemedicine usage will enhance patient health and offer accurate and current patient information. ^{47,75}
Telemedicine adoption (Adopt)	The degree of a physician's behavioral intention to use telemedicine service. ⁴⁷

the pre-adoption stage but not the post-adoption stage; extrinsic benefits (e.g., rewards and image enhancement) more effectively compensate for the difficulties and efforts the physician faces in the post-adoption stage. Likewise, Bagozzi and Dholakia⁵⁸ claimed that people will have the intention of joining a social organization if they become aware that they and other members share similar values. However, Cheung and Lee⁵⁹ failed to justify the influence of the shared similar values and goals of the online social networking intention. In contrast, Tong et al.⁵⁶ revealed that informational influence indirectly affects the physician's use of information systems in healthcare. Therefore, this study proposes that physicians may become aware of the value of telemedicine through interactions and sharing similar values with subordinates and peers. Consequently, these informational influences will cause physicians to use telemedicine. The hypothesis is proposed as follows:

H1: Informational influence (Info) exerts a positive influence on telemedicine adoption (Adopt).

Identification

Based on the psychological attachment theory, identification is another social influence approach that affects a person's behavior. Kelman³² defines identification as an individual's development of induced behavior to generate

a positive image with other people or groups. A person attempts to act like others who have reference power through identification. An individual's perception of the potential effects of using technology is therefore likely to be affected by the convincing information provided by significant others.⁶⁰

Image. According to Moore and Benbasat,⁶¹ image refers to the extent to which the use of an innovation is perceived to increase a person's image or status in his or her social system. Venkatesh and Davis⁵³ confirmed that images significantly affect user acceptance of technology. In addition, in an organizational setting, Malhotra and Galletta⁵⁰ revealed that identification positively impacts employees' system usage behavior. In the context of the healthcare field, Kummer et al.⁶² revealed the importance of image as a predictor of technology acceptance among healthcare personnel. However, Jeng and Tzeng⁶³ found that images had an insignificant influence on the intention to use healthcare-related systems among medical professionals. The rationale behind this might be that medical professionals are usually well-trained experts in their field; hence, they are less likely to be affected by social influences like the image factor.⁶³ Due to the inconsistent findings on the effects of images, more research is required. Chong et al.⁶⁴ also highlighted that the influence of image in the

healthcare context is a relatively understudied domain. Hence, we propose that image positively influences physicians' intentions to use telemedicine. Physicians who are inexperienced and new to telemedicine will more likely rely on more accessible cues to assess their use decision, like the anticipated image gain associated with technology use. With that, the hypothesis is posited as follows:

H2: Image (Image) exerts a positive influence on telemedicine adoption (Adopt).

Compliance (reward and sanction)

Compliance is "when a person accepts the induced behavior as he or she wishes to obtain favorable responses from another person or group." People tend to conform to compliance to get approval or rewards and to avoid punishments or sanctions. Following the concept proposed by Kelman,³² this study assesses compliance based on the expectations imposed on one by influential people in the context of rewards or sanctions. Previous studies have shown that compliance reflected through reward and sanction has a significant influence on changing an individual's behavior.^{65,66} In the existing literature, Podsakoff et al.⁶⁷ and Sims⁶⁸ discovered that rewards have a greater influence on the employee's performance than sanctions, while Liang et al.⁶⁵ found that sanctions have a greater effect.

Reward. Reward is when superiors apply positive consequences to subordinates. Reward refers to the positive outcomes that an employee expects to receive when engaging in the desired behavior, such as bonuses, recognition from supervisors, and salary increases.⁶⁹ Rewards are important because they serve as an external reinforcement for induced behavior.⁷⁰ Due to the absence of a new technology's actual usage experience, people often feel unsure of the new technology's performance. Hence, people will make decisions mostly based on the information obtained from supervisor advocacy and training.⁶⁶ Karahanna et al.⁷¹ revealed that the adoption ambiguity can be reduced and the technology is legitimized if the employee receives rewards from the supervisor or hospital administration. Previous research has shown that if employees are rewarded or receive approval, they can successfully develop technology acceptance.^{65,72} For instance, Malik et al.⁷⁰ showed that rewards would enhance the employee's performance in the creativity field. Also, Bulgurcu et al.⁷² found that rewards influence the employee's intention to comply with the security policy.

In the healthcare context, Tong et al.⁵⁶ discovered that rewards from hospital management can enhance the direct use of an electronic medical record (EMR) system. When the physician expects to obtain rewards from the

supervisors, they will perform the expected behavior.^{66,73} In China, Lu et al.⁵² also confirmed that the reward from hospital management or supervisors positively influences physicians' intention to use healthcare-related information technology in hospitals. According to Kelman,³² an individual is more likely to participate in a particular adoption behavior when they believe the agent will provide positive consequences (i.e., rewards). Based on the existing literature and discussion, this study proposes that rewards can positively influence the physician's intention to use telemedicine in hospitals. A hypothesis is posited as follows:

H3: Reward (Reward) exerts a positive influence on telemedicine adoption (Adopt).

Sanction. Another important element of compliance is sanction, which refers to the withdrawal of positive consequences or application of negative consequences from a supervisor such as coercion, punishment, or disapproval.⁶⁹ The impact of sanctions is significant as the employees typically wish to prevent unfavorable consequences, for instance, their supervisor's coercion or disapproval of any sort.⁷⁴ The concept of sanctions has been widely adopted in an organizational setting. Previous research on the organizational context revealed that sanctions and punishment can control the behavior of the employee and increase the firm's performance effectively.⁶⁷

During the pre-adoption stage, a physician would lack knowledge of using a new telemedicine system. Hence, the management can legitimize the behavior by imposing sanctions to lower the physician's uncertainties about new technology.⁷¹ When physicians want to prevent sanctions and avoid disapproval from their supervisors, they will comply with the desired behaviors.^{65,66,73} In the context of healthcare studies, Tong et al.⁵⁶ revealed that coercion from hospital management can increase the physician's direct use of the electronic medical record (EMR) system to avoid negative consequences. In addition, Lu et al.⁵² also confirmed that sanction would positively influence the physician EMR system acceptance. Hence, this study proposes that physicians would be inclined to use telemedicine if there are sanctions imposed. The hypothesis is posited as follows:

H4: Sanction (Sanction) exerts a positive influence on telemedicine adoption (Adopt).

Perceived Usefulness (PUse) and Perceived Ease of Use (PEoU)

Following a systematic literature review conducted by Garavand et al.,²⁷ the TAM was the most frequently adopted theory to explain physicians' telemedicine

acceptance. Specifically, PEOU and PUse from TAM are the two major predictors that influence telemedicine acceptance among physicians.^{27,45} PUse refers to the degree a physician perceives that telemedicine adoption will enhance the procedures and results of health treatment.⁴⁷ Whereas, PEOU is defined as a physician's perception of the ease of using telemedicine services.⁴⁷ Physicians deemed telemedicine useful if it improved patient care and delivery, reduced response time for medical services, improved documentation, enabled accuracy, and affordable health monitoring.^{47,75} In other words, physicians are inclined to use telemedicine if they perceive it as useful.

Previous studies have affirmed the importance of PEOU and PUse in the context of telemedicine. In Indonesia, Alexandra et al.⁴⁶ demonstrated that these factors, namely PEOU and PUse, have a positive impact on an individual's intention to use telemedicine services. In addition, Kamal et al.²² illustrated that within developing nations, PEOU and PUse play vital roles as predictors of telemedicine adoption. From the perspective of physicians, existing studies confirmed the impact of PEOU and PUse on physicians' intention to use telemedicine services.^{27,45,47,76} Based on the literature, this study proposes that:

H5: Perceived ease of use (PEoU) exerts a positive influence on telemedicine adoption (Adopt).

H6: Perceived usefulness (PUse) exerts a positive influence on telemedicine adoption (Adopt).

Moreover, prior research has demonstrated that PEOU directly affects the perceived usefulness of telemedicine among physicians.^{34,47,77,78} Similarly, this study proposes that physicians will perceive telemedicine to be useful if it is easy to use.

H7: Perceived ease of use (PEoU) exerts a positive influence on perceived usefulness (PUse).

Antecedents of PEOU and PUse

Self-efficacy (SE). According to Bandura,⁷⁹ self-efficacy refers to an individual's perception of being able to perform an action or a task according to certain scenarios. In this study, self-efficacy is defined as a physician's confidence in their ability to use telemedicine devices.^{47,77,80} Self-efficacy is one of the main factors that influence physicians' acceptance of telemedicine technology.²⁷ Zobair et al.⁸¹ confirmed that self-efficacy affects a person's expectations of telemedicine adoption. Many studies have confirmed the significant influence of self-efficacy in the telemedicine context.^{82,83} Moreover, self-efficacy also affects intention through PEOU and PUse.⁸⁴ For example, Rho et al.⁴⁷ discovered that physicians' self-efficacy significantly influences their perception of the ease of use and usefulness of telemedicine services. Hence,

this study proposes that greater self-efficacy among physicians will positively influence the PEOU and PUse of telemedicine. The hypotheses is proposed as follows:

H8: Self-efficacy (SE) exerts a positive influence on perceived ease of use (PEoU).

H9: Self-efficacy (SE) exerts a positive influence on perceived usefulness (PUse).

Accessibility of medical records (Record). The accessibility of medical records refers to the extent to which physicians perceive that telemedicine usage will enhance patient health and offer accurate and current patient information.^{47,75} Physicians have stated that improved accessibility of patient's medical records has led to quicker treatment delivery, shorter wait times for medical services, and more accurate medical assessments at lower costs.^{75,85} In addition, easy access to patient records has fostered improved documentation of patient's medical issues, allowing for the provision of accurate and timely patient records.⁷⁵ Access to medical records is critical for physicians' daily practices because it can lead to better clinical outcomes and healthcare performance.^{75,85} For instance, Sandberg et al.⁷⁵ revealed that physicians perceive telemedicine services as useful when they can access the patient's medical records conveniently by using telemedicine. Furthermore, Rho et al.⁴⁷ revealed that the accessibility of medical records significantly influences the physician's PUse of telemedicine but not the PEOU. With that, this study proposes that telemedicine will generate a positive perception of ease of use and usefulness among physicians when they have greater accessibility to medical records. Hence, the hypotheses are proposed:

H10: Accessibility of medical records (Record) exerts a positive influence on perceived ease of use (PEoU).

H11: Accessibility of medical records (Record) exerts a positive influence on perceived usefulness (PUse).

Accessibility of patients (Patients). Accessibility of patients refers to the degree to which physicians perceive that using telemedicine can enhance communication with underserved patients who reside far from medical institutions or hospitals.⁴⁷ Telemedicine services hold great promise for improving access to care for a wide range of medical conditions, particularly for patients who live far from medical facilities or in rural areas. During the COVID-19 pandemic, Bhatia⁸⁶ found that people living in rural areas have a high intention to use telemedicine services. According to medical research, telemedicine is a potential tool for increasing patient accessibility to healthcare facilities.²² The use of telemedicine allows physicians to provide medical consultation and care for patients

who are separated from physicians by geographic distances.⁸⁷ Telemedicine services play an important role and improve patient care effectiveness, especially when physicians have a heavy workload to warrant contacting patients. Furthermore, Rho et al.⁴⁷ revealed that in Korea, the PUse was significantly influenced by the accessibility of patients. Therefore, this study follows the previous findings and proposes the following hypothesis:

H12: Accessibility of patients (Patients) exerts a positive influence on perceived usefulness (PUse).

Material and methods

Questionnaire design

This study gathered data using a cross-sectional survey with a structured questionnaire. The questionnaire has two sections. The first section collects demographic information from respondents. The second section contains items related to the constructs in the research model, as illustrated in Figure 1. The measurement items tapping the theoretical constructs were developed based on an extensive literature review. They were adapted from Compeau and Higgins,⁸⁸ Lu et al.,⁵² Martinez et al.,⁸⁹ Moore and Benbasat,⁶¹ O'Reilly and Chatman,⁹⁰ Rho et al.,⁴⁷ Sandberg et al.,⁷⁵ Whitten et al.,⁸⁵ Vandenberg et al.,⁹¹ and Venkatesh and Davis,⁵³ thus satisfying content validity. The sources of the items in the survey questionnaire are displayed in Table 3. All the items in part B were constructed as “strongly disagree” to “strongly agree” statements on a five-point Likert scale. Before collecting data, we had two physicians review the questionnaires to ensure the language and item comprehension were appropriate.

Research sample and survey administration

There are varying opinions in the literature regarding the determination of an appropriate sample size for different types of statistical analyses. In this study, a priori sample size calculation was based on G-power. Thus, a minimum participant size of 109 would be required with a 0.15 effect size, 0.05 alpha level, and 0.8 power.

The survey was conducted from February 2022 to August 2022. The sample comprises physicians with various specializations from both private and public hospitals in Wilayah Persekutuan Kuala Lumpur and Selangor, Malaysia. Specifically, we included respondents from the medical department and the primary care department due to their frequent reliance on telemedicine for managing chronic conditions and providing routine check-ups remotely. We excluded respondents from the surgical department and other departments as their telemedicine utilization is comparatively lower. By focusing on the medical and

Table 3. Operationalization of constructs.

Constructs	Sources
Reward	O'Reilly and Chatman ⁹⁰
Sanction	Lu et al. ⁵²
Image	Moore and Benbasat ⁶¹
Informational influences (Info)	Vandenberg et. al. ⁹¹
Self-efficacy (SE)	Compeau and Higgins ⁸⁸
Perceived usefulness (PUse), Perceived ease of use (PEoU)	Venkatesh and Davis ⁵³
Telemedicine adoption (Adopt)	Lu et al. ⁵²
Patients	Rho et al. ⁴⁷ , Martinez et al. ⁸⁹
Record	Rho et al. ⁴⁷ , Whitten et al. ⁸⁵ , Sandberg et al. ⁷⁵

primary care departments, we aim to gather insights relevant to the effective implementation of telemedicine services in Malaysian hospital settings.

We created an online invitation containing a link to a questionnaire on Google Forms; the invitation was distributed through email and WhatsApp. We included a cover letter outlining the research objective within the survey. At the survey's outset, we identified the target audience to ensure respondents were our target audience. We described telemedicine to help respondents understand the technology used in the hospital. Written informed consent was sought from all respondents, who retained the right to withdraw at any time. Participation in this study was entirely voluntary and no compensation was offered. A total of 251 responses were collected. To handle non-responses effectively, we implemented rigorous data cleaning procedures before conducting data analysis. Some survey responses were excluded due to missing data or refusal to provide written consent, leaving a valid sample of 230 responses for further analysis. Given the physicians' busy schedules, the number of responses obtained was deemed satisfactory.

Statistical analysis and results

Data analysis was performed using SPSS software for descriptive analysis. For the measurement and structural models, this study used Partial Least Squares Structural Equation Modeling (PLS-SEM) because it does not rely on the assumption of normality. Additionally, it is better suited for studies involving formative constructs as

suggested by Chin.⁹² Considering that survey data often does not follow a normal distribution and this study incorporates multiple formative constructs, PLS-SEM was utilized through SmartPLS version 3.2.8 for the data analysis.

Respondent demographics

The demographic information of the respondents is presented in Table 4. As shown, 73.5% of the respondents were female. The distribution of the respondents was 53.9% Malay, 33% Chinese, and 12.1% Indian. The respondents' ages ranged from 20 years to over 50 years; the highest frequency was observed in the age group of 30–39 years (52.2%). The respondents were from the medical department (86.1%) and the primary care department (13.9%). The career longevity of respondents was as follows: less than 1 year (2.7%), 1–5 years (5.5%), 6–10 years (24.5%), and more than 10 years (67.3%). The respondents were employed by university hospitals (69.1%), tertiary government hospitals (17.8%), district government hospitals (3.9%), and private practices (9.1%).

Common method bias

To address the issue of common method bias, this study conducted the marker variable test, a well-established approach for evaluating common methods bias (CMB).⁹³ In the questionnaire, we included an unmeasured marker variable,⁹⁴ which was conceptually unrelated to the other constructs. The results are presented in Table 5. They demonstrate that the R^2 changes were below 10% even with the inclusion of the marker variable, indicating the absence of significant CMB in this study.

Evaluating the measurement model

Before proceeding with hypothesis analysis, it's crucial to assess the reliability and validity of the measurement items. This study examined the measurement model to evaluate the instrument's validity and reliability, following Hair et al.⁹⁵ guidelines. Since the model in this study comprises both formative constructs and reflective measurement items, the assessment criteria differ slightly. Subsequently, a structural model was employed to test the developed hypotheses.

Formative measurement model. This study involved four formative constructs (image, information, rewards, and sanction), which were validated following the guidelines proposed by Petter et al.⁹⁶ and Cenfetelli and Bassellier.⁹⁷ To assess the measurement model for these constructs, we examined weights, t-values, and variance inflation factors (VIF). First, we addressed the multicollinearity issue among the formative indicators using VIF. All VIF values

Table 4. Respondents' information (n = 230).

Characteristics	Frequency	Distributions (%)
Gender		
Female	169	73.5
Male	61	26.5
Ethnicity		
Malay	124	53.9
Chinese	76	33.0
Indian	28	12.1
Age		
20–29 years-old	49	21.3
30–39 years-old	120	52.2
40–49 years-old	50	21.7
50 years-old and above	11	4.8
Department		
Medical	198	86.1
Primary care	32	13.9
Career		
Less than 1 year	3	2.7
1–5 years	6	5.5
6–10 years	27	24.5
more than 10 years	74	67.3
Hospital institution		
University hospital	159	69.1
Tertiary general hospital	41	17.8
District General hospital	9	3.9
Hospital/private practice	21	9.1

below 5 indicated no significant multicollinearity,⁹⁸ as seen in Table 6.

Next, we evaluated the significance and relevance of item weights in formative measurement models as the second step in our assessment.⁹⁸ We employed a

Table 5. Common method variance.

	R ² (Before adding in marker variable)	R ² (After adding in marker variables)
Adopt	0.469	0.475
PEoU	0.510	0.576
PUse	0.604	0.607

bootstrapping procedure and generated 5000 subsamples to determine if outer weights in formative measurement models significantly differed from zero. One formative construct (Image) displays both positive and negative indicator weights. It is worth noting that negative weights may impact individual indicator interpretation but not the structural effects within the model, as indicated by previous research.⁹⁷ Additionally, removing an indicator should be done with caution, considering conceptual overlap which guided our decision to proceed with the existing indicators.

Reflective measurement model. For the reflective constructs (ease of use, patients, records, self-efficacy, usefulness, and intention), we evaluated the convergent and discriminant validities. To gauge convergent validity, we assessed loadings, average variance extracted (AVE), and composite reliability (CR) to assess the reflective measurement model. Guided by established thresholds, loadings should be ≥ 0.708 , the AVE should be ≥ 0.5 and the CR should be ≥ 0.7 . As shown in Table 6, all item loadings exceeded 0.708, AVE values surpassed 0.5, and CR values were above 0.7. For discriminant validity, the HTMT criterion^{99,100} was used. The results presented in Table 7 demonstrated that all HTMT values were below 0.85, even for the stricter criterion. Consequently, we can confidently conclude that respondents recognized the distinctiveness of all constructs. In summary, these validity tests confirm that the reflective measurement items are both valid and reliable.

Structural model

Based on Hair et al.,¹⁰¹ we used multivariate skewness and kurtosis to examine the normality of our data. The results indicated significant Mardia's multivariate skewness ($\beta = 22.515$, $p < 0.01$) and Mardia's multivariate kurtosis ($\beta = 174.274$, $p < 0.01$), revealing that our collected data was not multivariate normal. Therefore, we opted for SmartPLS, a non-parametric analysis software, for our data analysis.

Once all variables in the measurement model met specific thresholds in the reliability and validity thresholds, we delved deeper into investigating the research

hypotheses in the structural model. As suggested by Hair et al.,⁹⁵ we used a 5000-sample bootstrapping procedure to evaluate path coefficients, standard errors, t-values, and p-values for the structural model. Additionally, we employed a combination of p-values, confidence intervals, and effect sizes to assess hypothesis significance. Table 8 and Figure 2 show the criteria used to evaluate the developed hypothesis.

Initially, we examined the effect of the six predictors on Adopt, resulting in an R² of 0.469 ($Q^2 = 0.395$), indicating that all six predictors collectively explained 46.9% of the variance in Adopt. Specifically, Info ($\beta = 0.202$, $p = 0.037$), Reward ($\beta = 0.169$, $p = 0.048$), PEoU ($\beta = 0.205$, $p = 0.042$), and PUse ($\beta = 0.423$, $p < 0.01$) exhibited positive relationships with Adopt, while Image ($\beta = 0.013$, $p = 0.454$) and Sanction ($\beta = 0.074$, $p = 0.215$) showed no relationship with Adopt. Thus, only hypotheses H1, H3, H5, and H6 were supported in this study, while H2 and H4 were not.

Next, we tested the effect of four predictors on PUse, resulting in an R² of 0.604 ($Q^2 = 0.589$). This indicates that all four predictors collectively accounted for 60.4% of the variance in PUse. Notably, PEoU ($\beta = 0.323$, $p < 0.01$), Record ($\beta = 0.402$, $p < 0.01$), and Patients ($\beta = 0.128$, $p = 0.049$) displayed positive relationships with PUse, while SE ($\beta = 0.066$, $p = 0.312$) showed no significant relationship with it. Consequently, the hypotheses H7, H11, and H12 were supported in this study, but H9 was not.

Next, we assessed the effect of the two predictors on PEoU, leading to an R² of 0.510 ($Q^2 = 0.501$), explaining 51% of the variance in PEoU. Both SE ($\beta = 0.476$, $p < 0.01$) and Record ($\beta = 0.305$, $p < 0.01$) exhibited positive relationships with PEoU, supporting hypotheses H8 and H10.

Building upon the earlier hypothesis testing, the bias-corrected 95% confidence intervals for all hypotheses (except H2, H3, and H9) did not span zero, thus affirming their support. Conversely, H2, H4, and H9 were not supported, as their confidence intervals crossed 0.

To assess predictive relevance, we performed the PLSpredict analysis using a ten-fold procedure, following Shmueli et al.¹⁰² PLSpredict generates case-level predictions at an item or construct level. According to Shmueli et al. (2019), there is strong predictive power if all item differences (PLS-LM) are lower than a threshold. In our case, all errors of the PLS model were lower than the LM model, indicating strong predictive power as shown in Table 9.

Importance-performance map analysis

IPMA aims to assess the importance and performance of the predecessor constructs in explaining the target construct (Adopt). It identifies variables with high importance but relatively low performance,¹⁰³ indicating areas with potential for improvement and requiring special attention. In this study, we conducted an importance-performance map

Table 6. Measurement model.

Constructs	Items	Scale	Loadings	Composite Reliability	Average Variance Extracted (AVE)
PEoU	PEoU1	Reflective	0.886	0.921	0.795
	PEoU2		0.901		
	PEoU3		0.888		
PUse	PUse1	Reflective	0.874	0.903	0.699
	PUse2		0.826		
	PUse3		0.834		
	PUse4		0.809		
Patients	Patients1	Reflective	0.959	0.958	0.919
	Patients2		0.958		
Record	Record1	Reflective	0.929	0.956	0.88
	Record2		0.943		
	Record3		0.942		
SE	SE1	Reflective	0.795	0.896	0.683
	SE2		0.787		
	SE3		0.865		
	SE4		0.855		
Adopt	Adopt1	Reflective	0.914	0.954	0.874
	Adopt2		0.945		
	Adopt3		0.945		
			Weights	t-value	VIF
Info	Info1	Formative	0.142	0.643	2.406
	Info2		0.887	4.957	2.406
Image	Image1	Formative	1.362	1.822	4.718
	Image2		-0.430	0.489	4.718
Reward	Reward1	Formative	0.651	0.908	3.468
	Reward2		0.388	0.537	3.468
Sanction	Sanction1	Formative	0.023	0.033	2.818
	Sanction2		0.981	1.516	2.818

analysis (IPMA) as a post-hoc procedure in PLS, using performance impact as the outcome construct.

As per Aldholay et al.,¹⁰⁴ in IPMA, the average latent variable scores of predecessor constructs represent their performance, whereas the total effects of predecessor constructs indicate their importance in shaping the target construct (Adopt). Performance scores were scaled from 1 to 100, with 1 indicating the lowest performance and 100 the highest (Hair et al., 2016). The results from Table 10 indicate the importance (total effects) and performance of

predecessor constructs concerning the target construct (Adopt).

The IMPA results revealed that the highest importance lies with PUse (0.423), followed by PEOU (0.341), and Info (0.202) as the result of their comparatively greater importance in comparison with that of other constructs within the proposed model. Therefore, to enhance telemedicine adoption, managerial efforts should prioritize focusing on telemedicine aspects related to PEOU, Puse, and Info.

Table 7. HTMT_{.85} criterion.

	1	2	3	4	5	6
PEoU						
PUse	0.766					
Patients	0.47	0.562				
Record	0.673	0.782	0.512			
SE	0.774	0.728	0.671	0.733		
Adopt	0.603	0.712	0.507	0.641	0.684	

Table 8. Direct effects.

Hypothesis	Relationship	Std. Beta	Std. Deviation	t-value	p-value	BCI LL	BCI UL	f2
H1	Info → Adopt	0.202	0.113	1.784	0.037	0.022	0.396	0.039
H2	Image → Adopt	0.013	0.113	0.116	0.454	-0.185	0.178	0.000
H3	Reward → Adopt	0.169	0.102	1.663	0.048	0.039	0.381	0.026
H4	Sanction → Adopt	0.074	0.093	0.788	0.215	-0.070	0.236	0.007
H5	PEoU → Adopt	0.205	0.119	1.724	0.042	0.008	0.401	0.043
H6	PUse → Adopt	0.423	0.125	3.392	0.000	0.229	0.639	0.139
H7	PEoU → PUse	0.323	0.108	2.983	0.001	0.147	0.499	0.129
H8	SE → PEoU	0.476	0.105	4.541	0.000	0.304	0.645	0.262
H9	SE → PUse	0.066	0.136	0.49	0.312	-0.144	0.296	0.004
H10	Record → PEoU	0.305	0.113	2.707	0.003	0.121	0.485	0.108
H11	Record → PUse	0.402	0.114	3.532	0.000	0.216	0.586	0.204
H12	Patients → PUse	0.128	0.077	1.657	0.049	-0.005	0.247	0.027

Note. We use 95% confidence interval with a bootstrapping of 5000

Discussion

This study developed a research model based on the TAM and Kelman's Social Influence Theory to investigate physicians' intention to use telemedicine. Kelman's Social Influence Theory was incorporated to account for various dimensions of social influence, including compliance (reward and sanction), identification (image), and internalization (informational influences). Additionally, we proposed a hypothesis for PEOU and PUse based on the TAM. Furthermore, this study introduced the individual factor of self-efficacy and clinical factors of patient and medical record accessibility as antecedents of TAM constructs. The results of our hypothesis testing are summarized in Table 11.

From the dimension of social influence, Reward and Info bolster physicians' telemedicine adoption, while Image and

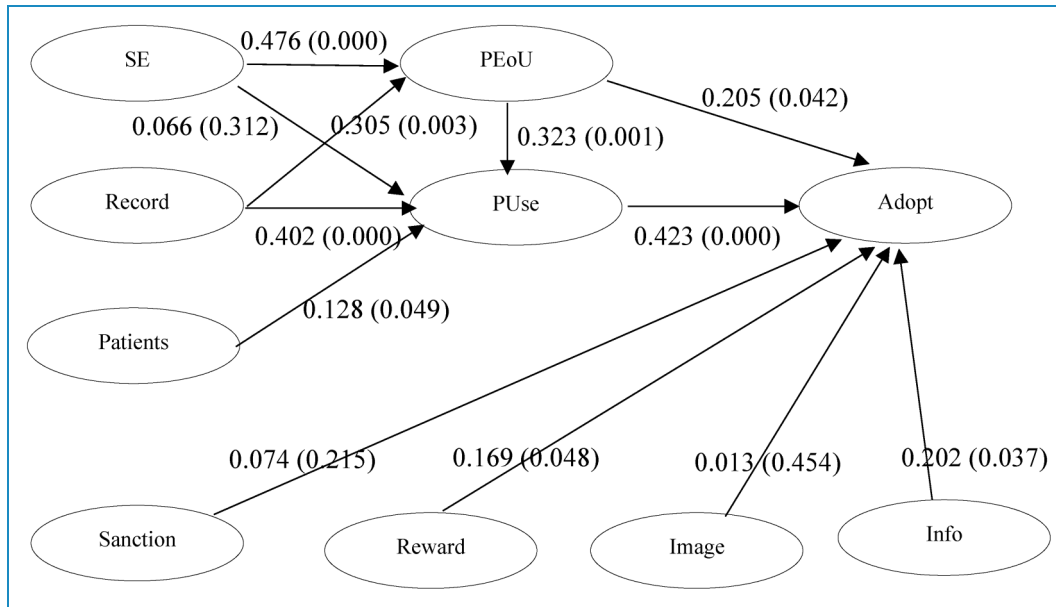


Figure 2. Results of hypothesis testing.

Sanction have no effects. The findings align with earlier studies^{56,67,68} that found that rewards significantly influence adoption. This suggests that physicians are more likely to embrace telemedicine when they expect positive outcomes (rewards) from their supervisors. In addition, the positive influence of the informational influences is also in line with previous studies such as Lu et al.,⁵² who found that informational influence was positively related to the physician’s acceptance of healthcare technology during the pre-adoption period. Hence, informational influence plays an important role in influencing telemedicine adoption as physicians may become aware of the value of telemedicine through interactions with their colleagues. Consequently, they will adopt telemedicine due to these informational influences. However, this study revealed that image and sanction do not influence telemedicine adoption among physicians. The insignificance of image in this study aligns with Jeng and Tzeng’s⁶³ findings; however, it contradicts the findings of Malhotra and Galletta⁵⁰ as well as Kummer et al.⁶² The insignificant influence of image may stem from the nature of physicians’ healthcare practice, as they often view themselves as healthcare professionals primarily responsible for providing patient care. Consequently, physicians may not associate telemedicine with image enhancement.⁵⁶ Conversely, this study also found an absence of influence from sanctions, which differs from the results of Tong et al.⁵⁶ and Lu et al.⁵² One plausible explanation for this finding is that, within the context of compliance, physicians tend to focus more on achieving gains and rewards rather than avoiding loss or sanctions.

The study findings indicate that PEOU and PUse positively influence physicians’ adoption of telemedicine.

Table 9. PLS-Predict.

Constructs	Q ² _predict			
Adopt	0.384			
Constructs	Items	PLS	LM	PLS-LM
	Adopt1	0.749	0.849	-0.100
Adopt	Adopt2	0.687	0.718	-0.031
	Adopt3	0.680	0.737	-0.057

Furthermore, this study also revealed that when they find telemedicine easy to use, it enhances their perception of its usefulness, aligning with prior literature.^{34,47,77,78} This suggests that physicians are more likely to embrace telemedicine in their healthcare services when it’s user-friendly with significant benefits for diagnosis and healthcare management. Conversely, if the telemedicine application is perceived as complex, physicians may hesitate to use it due to the additional time and effort required to familiarize themselves with new technology.⁴⁶ As highlighted by Chau and Hu,¹⁰⁵ health professionals tend to adopt a pragmatic approach in their decisions regarding technology acceptance and prioritize the usefulness offered by the technology. Accordingly, this study showed that PUse plays a crucial role in telemedicine adoption among physicians. These results align with similar findings from previous telemedicine studies,^{27,45,76} but contradict studies such as Hoque et al.¹⁰⁶ The significant role of perceived ease of

Table 10. Importance-performance map analysis.

	Performances	Importance
PEoU	65.775	0.341
PUse	66.190	0.423
Patients	69.587	0.054
Record	68.119	0.274
SE	69.407	0.191
Info	64.751	0.202
Image	49.008	0.013
Reward	51.152	0.169
Sanction	32.460	0.074

Table 11. Summary of hypothesis testing.

Hypothesis	Relationship	p-value	Decision
H1	Info → Adopt	0.037	Supported
H2	Image → Adopt	0.454	Not Supported
H3	Reward → Adopt	0.048	Supported
H4	Sanction → Adopt	0.215	Not Supported
H5	PEoU → Adopt	0.042	Supported
H6	PUse → Adopt	0.000	Supported
H7	PEoU → PUse	0.001	Supported
H8	SE → PEoU	0.000	Supported
H9	SE → PUse	0.312	Not Supported
H10	Record → PEoU	0.003	Supported
H11	Record → PUse	0.000	Supported
H12	Patients → PUse	0.049	Supported

use and PUse in telemedicine adoption in Malaysia is consistent with the healthcare context of other countries such as Pakistan²² and Indonesia.⁴⁶

Regarding the factors that influence TAM constructs, this study discovered that both proposed clinical factors of patient accessibility and medical record accessibility have a positive effect on PUse. These findings suggest

that physicians view telemedicine as useful when it offers improved access to patients and their medical records, which is in line with the findings of Rho et al.⁴⁷ This could be because telemedicine excels at bridging the gap with underserved patients in remote areas, enhancing the physician's ability to provide efficient healthcare services. Additionally, easy access to patient records through telemedicine can enhance patient care and provide accurate and current information for physicians. Contrary to the findings of Rho et al.⁴⁷ in the Korean setting, this study revealed that a physician's self-efficacy does not impact their perception of telemedicine's usefulness. This discrepancy can be rationalized by acknowledging self-efficacy as an individual factor that varies among individuals. Moreover, a physician's belief in their capabilities does not directly influence their perception of telemedicine's usefulness. Instead, they appear to prioritize clinical factors such as patient and record accessibility when evaluating telemedicine's usefulness.

Lastly, medical record accessibility and self-efficacy positively influence physicians' perception of telemedicine's ease of use. The significance of self-efficacy in the telemedicine context aligns with the majority of previous studies.^{82,83} However, the significant role of medical record accessibility in the current study contradicts Rho et al.,⁴⁷ who did not find a significant relationship in their study. Since telemedicine is a relatively new and innovative technology, physicians who believe in their ability to use it will find it easy to use. Moreover, improved access to patient medical records allows physicians to access up-to-date patient information, leading to more accurate and effective healthcare treatment. This streamlined process can contribute to a smoother, more seamless telemedicine experience and ultimately enhance the perception of its ease of use among physicians.

Study limitations and future research

This study has certain limitations that should be considered when interpreting the findings. It's important to bear in mind the constraints associated with survey-based research, which relies on self-administered questionnaires and has a relatively low response rate. Firstly, the study's observational and cross-sectional design prevents us from establishing causal relationships between variables, given the heightened risk of endogeneity. Longitudinal studies are necessary to assess the impact of telemedicine adoption over time. Secondly, due to the limited participation rate, the results of our study may not fully indicate the factors influencing telemedicine adoption among all physicians. Thirdly, as with many questionnaire-based studies, self-reported information can introduce a social desirability bias that might impact the results. As respondents answered the survey with their organization as the

frame of reference, findings may be limited to the surveyed organizations and lack universal applicability. Additionally, bias may have occurred due to the survey's sole reliance on respondents' perceptions within their organizations. To address this, future studies should use a diverse sample and conduct comparative analyses across organizational contexts to enhance the generalizability of findings and identify contextual factors affecting outcomes.

Theoretical and practical implications

Theoretical contributions

In Malaysia, telemedicine has great potential to fulfill the country's increasing demand for healthcare services. Furthermore, the use of telemedicine services can strengthen the traditional healthcare services that are currently in place. Nevertheless, telemedicine usage is not widely utilized in Malaysia. It is therefore important to investigate the factors that affect telemedicine adoption among physicians. Hence, this study makes a significant contribution to the limited research on telemedicine adoption in Malaysia by integrating the TAM and Kelman's Social Influence Theory to analyze physicians' intentions to use telemedicine. The research model encompasses clinical factors (e.g., accessibility of medical records and patients), individual factors (e.g., self-efficacy), and multidimensional social influence factors (e.g., image and informational aspects).

The integration of TAM with Kelman's Social Influence Theory goes beyond the conventional focus on compliance-based social influences found in typical technology acceptance models like UTAUT. By incorporating Kelman's theory, which considers compliance, identification, and internalization aspects of social influence, this study comprehensively investigates telemedicine adoption among physicians. Specifically, the integration of theories is important as it expands the focus beyond mere compliance-based social influence, which tends to lose its impact over time as individuals gain experience. In contrast, the identification and internalization aspects of social influence as proposed in Kelman's Social Influence Theory, are more likely to have a lasting impact. Existing studies shown in Table 1, such as those by Cobelli et al.¹⁴ and Vidal-Silva et al.,¹⁵ primarily emphasize compliance aspects of subjective norms. They overlook the critical processes of identification and internalization in social influence, as noted by Wang et al.²⁵ To fill these gaps, this study builds upon recent advancements by Malhotra and Galletta,⁵⁰ Wang et al.,²⁵ and Lu et al.⁵² to propose a more comprehensive framework for understanding telemedicine adoption among physicians, especially in developing countries like Malaysia. The research can shed more light on physicians'

perspectives on telemedicine and the factors considered by physicians when deciding whether to use telemedicine.

Next, this study also contributes to Kelman's Social Influence Theory by first applying this theory to understand the physician's telemedicine adoption in the context of Malaysia. In addition, this research also contributes to the existing literature by investigating the impact of social influences in multidimensional perspectives, which is theorized from Kelman's Social Influence Theory and able to explain the inconsistent effect of social influence in earlier studies. The findings highlight that not all dimensions of social influence equally influence a physician's adoption of telemedicine. This nuanced understanding can serve as a foundational framework to guide future research in this emerging field. By emphasizing the significance of considering multiple dimensions of social influence, researchers can more accurately capture and understand their impact on technology adoption. This comprehensive approach is essential for developing effective strategies and interventions to ensure the successful adoption and integration of technologies such as telemedicine into healthcare practices.

Practical implications

This study demonstrated that reward and informational influences can effectively encourage physicians to adopt telemedicine. However, the managerial level needs to be aware that emphasizing image and sanction does not effectively encourage telemedicine adoption. Thus, hospital management should acknowledge the importance of reward and informational influences and use these mechanisms to promote telemedicine use. For instance, management can reward physicians who use telemedicine effectively in healthcare services.

Policymakers may leverage this finding to design incentive structures and allocate funding within healthcare policies, including implementing reward systems or bonuses for physicians who demonstrate efficient utilization of telemedicine services. In addition, informational campaigns can be created to teach medical staff members about the features and advantages of telemedicine. This will promote an integrated and accepting culture in healthcare settings.

This study also revealed that the physicians' perception of telemedicine's ease of use and usefulness positively influences their adoption, aligning with the original TAM framework. In addition, when telemedicine is easier to use, physicians find it more useful. This highlights the importance of technological factors, such as ease of use and usefulness, in the Malaysian healthcare context. Service providers should ensure that the features and functions of telemedicine are user-friendly and beneficial to increase physicians' willingness to use it. Specifically, policymakers should prioritize investments that enhance the technological infrastructure supporting telemedicine

services, given the critical importance of technological criteria such as usefulness and ease of use. This may involve allocating funding for projects aimed at developing user-friendly telemedicine platforms and ensuring widespread access to essential technology resources among physicians.

Furthermore, this study found that clinical factors, including accessibility of patients and medical records, positively influence physicians' perceptions of telemedicine as a useful tool in healthcare. Therefore, telemedicine service providers should prioritize these clinical needs. For instance, they can enhance patient and medical record accessibility by establishing secure network systems that enable physicians to access patient information and records anywhere, anytime. With that, physicians can stay updated on patient health and reach underserved patients more effectively, ultimately improving the usefulness of telemedicine.

Next, the ease of accessing records and a physician's self-efficacy were shown to make telemedicine easier for physicians to use. Policymakers can engage in collaborative efforts with hospitals to establish training and support programs tailored to equip physicians with the essential skills and confidence required for the effective utilization of telemedicine services. Additionally, integrating telemedicine training into medical curricula prepares future physicians to use these tools confidently and effectively, meeting evolving healthcare needs. Moreover, policymakers can facilitate future collaboration between stakeholders to ensure seamless integration and exchange of patient records across different telemedicine platforms, thereby reducing barriers to access and improving ease of use for physicians.

In conclusion, the study's findings have significant practical implications for management, practitioners, and policymakers. Collaborative efforts among these stakeholders will optimize the adoption of telemedicine to enhance healthcare accessibility, efficiency, and quality in Malaysia. As a result, these developments could have a significant positive impact on healthcare systems as well as society as a whole. They would improve patient experiences, lower the cost of care, and boost resilience in the face of changing healthcare obstacles.

Conclusion

Promoting telemedicine acceptance among healthcare professionals presents a significant challenge, yet it is crucial for the successful implementation of telemedicine initiatives. This study significantly contributes to understanding telemedicine adoption among Malaysian physicians by integrating TAM and Kelman's Social Influence Theory. The findings enrich the existing literature by shedding light on how technological factors, clinical factors, and the various dimensions of social influence exert differential effects on physicians' acceptance of telemedicine in

Malaysia. This research lays a solid foundation for future studies and implementation strategies, and it fosters the seamless integration of telemedicine into healthcare practices.

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Appendix 1. Constructs and items.

Construct	Item	Source
Reward	• How hard I work on using the telemedicine services will be [is] directly linked to how much I am rewarded by the hospital management.	O'Reilly and Chatman ⁹⁰
	• How hard I work on using the telemedicine services will be [is] directly linked to how much I am recognized by my supervisor.	
Sanction	• To avoid punishment in my job by the hospital management, the telemedicine services usage will be [is] necessary.	Lu et al. ⁵²
	• If I do not use the telemedicine services, my supervisor will disapprove me.	
Image	• Using the telemedicine services will improve my image among my departmental peers.	Moore and Benbasat ⁶¹
	• Using the telemedicine services will improve my image among my hospital peers outside my department.	
Informational influences (Info)	• Based on my observation of my departmental peers, what the telemedicine services usage stands for is important to me.	Vandenberg et al. ⁹¹
	• Based on my observation of my professional peers, what the telemedicine services usage stands for is important to me.	
Self-efficacy (SE)	• I could complete a job or a task using telemedicine if I could call someone for help if I get stuck.	Compeau and Higgins ⁸⁸
	• I could complete a job or a task using telemedicine if I had just the built-in help facility for assistance.	
	• I am confident in using the functions of telemedicine.	
	• I am confident in my understanding of the content of telemedicine.	
Perceived usefulness (PUse)	• Using telemedicine will positively affect the treatment plan.	Venkatesh and Davis ⁵³
	• Telemedicine is possible to provide more comprehensive care service.	
	• Telemedicine is efficient for diagnosing patients and scheduling.	
	• I can precisely monitor the patient's condition by using telemedicine.	
Perceived ease of use (PEoU)	• It is easy to use the devices for telemedicine services.	Venkatesh and Davis ⁵³
	• It is easy to learn how to use the new devices for telemedicine.	
	• It is easy to perform my job by using the telemedicine services.	
Telemedicine adoption (Adopt)	• I have a positive intention to adopt the telemedicine service.	Lu et al. ⁵²
	• I will gain accurate patient information and treatment histories if I use telemedicine service.	

(continued)

Continued.

Construct	Item	Source
	<ul style="list-style-type: none"> • I will provide telemedicine services and share the information through this service. 	
Patients	<ul style="list-style-type: none"> • I am able to be in contact with patients who seldom come to the clinic through telemedicine services. • I am able to be in contact with patients who cannot be easily delivered to the clinic through telemedicine services. 	Rho et al. ⁴⁷ , Martinez et al. ⁸⁹
Record	<ul style="list-style-type: none"> • I can gather correct information about the patient by using telemedicine. • I can easily record a patient's health condition with telemedicine services. • Because of the precise record keeping of the patients in telemedicine, it enables me to provide proper healthcare service to my patients. 	Rho et al. ⁴⁷ , Whitten et al. ⁸⁵ , Sandberg et al. ⁷⁵

Questions regarding marker variable⁹⁴

“Once I have come to a conclusion, I’m not likely to change my mind”; “I do not change my mind easily”; “My views are very consistent over time”.