Determinants of Telemedicine Security Readiness Among ICT Professionals: Extended UTAUT Model

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***Abstract*—Ensuring strong security readiness in telemedicine is essential to protect patients, safeguard their data, and build confidence and satisfaction in today's digital healthcare platforms. Hence, this research explores and evaluates the maturity of telemedicine services from the perspectives of ICT professionals focused on security readiness. A case study with a stratified survey was conducted among ICT personnel in public hospitals in Malaysia, revealing critical gaps by examining professionals in authority for system security, data fortification, infrastructure resilience, and operational endurance of the telemedicine platform. The UTAUT model employed in this study incorporates two additional constructs, Trust in Technology and Adaptability. Trust in technology captures confidence in system safety, data privacy, and dependability. The adaptability, focused on system technical areas and user-related factors, towards secure telemedicine adoption. The SPSS Statistics Version 21 was used to analyze the data, retaining descriptive statistics, reliability testing, correlation analysis, and multiple regression. Results indicated a generally high level of security readiness among ICT professionals, with strong Trust in Technology and Adaptability to telemedicine systems. Facilitating Conditions, particularly the availability of secure infrastructure and technical safeguards, emerged as the most influential factor and significantly predicted Performance Expectancy. Although Trust in Technology and Adaptability exhibited strong positive correlations with key UTAUT constructs, their effects were statistically significant in the regression analysis, supporting all proposed hypotheses, including their influence on Satisfaction, which suggests a direct role in shaping security readiness.**

***Keywords*—Telemedicine; security readiness; ICT professionals; UTAUT; healthcare systems**

I. Introduction

Telemedicine has emerged as a vital component of digital healthcare delivery, particularly in addressing remote clinical services. However, beyond accessibility and efficiency, the security readiness of the telemedicine system has become a critical concern, especially as healthcare services increasingly rely on digital platforms for exchanging sensitive patient data. In Malaysia, the COVID-19 pandemic significantly accelerated the adoption of teleconsultation services across public and private healthcare sectors, with usage increasing sharply in primary and hospital settings [1], [2]. This was driven by the increasing need for remote consultation and outpatient care management with a reduced risk of infection.

Despite growing adoption, the success of telemedicine systems remains hindered by numerous challenges, including infrastructural limitations, security vulnerabilities, data security concerns, usability issues, and user trust in technology for secure system operations [3], [4]. These factors can hinder system performance and limit broader acceptance, mainly when not adequately addressed during implementation.

ICT (Information and Communication Technology) staff play a pivotal role in successfully deploying, maintaining, and integrating telemedicine platforms, particularly in ensuring system security, access control, data confidentiality, and resilience against operational risks. However, their perspectives are often underrepresented in policy and academic discourse, despite their experience being crucial to identifying real-world operational challenges and technical shortcomings [5].

This study employs an extended version of the Unified Theory of Acceptance and Use of Technology (UTAUT) model to assess ICT staff's perceptions of telemedicine system performance in Malaysian public hospitals. The original UTAUT framework, designed to assess technology acceptance, has been enhanced in this study by incorporating two additional constructs: trust in Technology and Adaptability, which are especially relevant in healthcare environments [6].

The primary objectives of this study are to: 1) investigate infrastructural and organizational barriers experienced by ICT personnel in supporting telemedicine services, 2) assess key predictors of system acceptance and performance from the ICT perspective, and 3) propose actionable recommendations to support more effective integration of telemedicine in Malaysia's hybrid healthcare eco-system. In this study, telemedicine security readiness refers to the organizational and technical preparedness to deploy telemedicine securely, including trusted systems, secure infrastructure, adaptable users, and effective digital workflows.

II. Related Work

Telemedicine adoption as an e-government service has been extensively studied using technology acceptance frameworks, particularly the Unified Theory of Acceptance and Use of Technology (UTAUT) [6], [7]. Venkatesh et al. [6] originally proposed UTAUT to evaluate Technology Adoption (TA), identifying Performance Expectancy (PE), Effort Expectancy (EE), and Social Influence (SI) as critical determinants. However, most UTAUT applications in healthcare focus on end users (patients, clinicians), neglecting the pivotal role of ICT staff in system implementation and in safeguarding the integrity and data protection [6], [5].

In Malaysia, the adoption of telemedicine surged during the COVID-19 pandemic, driven by policy initiatives such as the

Virtual Clinic program [5]. Studies such as [8] revealed that 66.3% of Malaysian healthcare workers viewed telemedicine as complementary to traditional care, but 29.1% resisted adoption without prior physical patient interactions, highlighting challenges related to trust and workflow integration. Notably, the perspectives of ICT workers were underrepresented, despite their critical role in addressing infrastructural barriers (e.g., cybersecurity, interoperability) [9].

Globally, UTAUT extensions have incorporated more constructs to better predict adoption in healthcare [8], [9]. For example, Marcelo et al. [10] applied UTAUT to telemedicine adoption in the Philippines, finding that adaptability and facilitating conditions (e.g., training) were key for ICT staff acceptance. Similarly, Rahman et al. [7] demonstrated that task-technology fit significantly influenced telemedicine adoption during the COVID-19 pandemic. Considering insights from existing studies provides a relevant indication that two additional constructs are required to evaluate ICT professionals' perspectives. Thus, the additional constructs added as extensions of the UTAUT model in this study are: technology trust (TT) and adaptability (AD). The relevance of the new extension of this model will be further investigated in this study to demonstrate that the new constructs are significant in evaluating the perspectives of ICT Healthcare Professionals.

There are many other related studies that contributed to the electronic medical records framework, IT capability in the Malaysian healthcare system, and the assessment of patient risks that revolve in the healthcare domain [11], [12], [13]. Despite advances contributed to in numerous studies, gaps persist in many areas of research, particularly in the Malaysian context, regarding ICT personnel in the implementation of telemedicine. Prior studies have focused on clinicians' perceptions [8] or patient satisfaction [14], with limited attention to telemedicine security assurances and the role of ICT professionals responsible for safeguarding system integrity and data protection [15]. Although trust has been examined in the context of telemedicine adoption, it is often treated as a behavioral factor rather than as a contextual factor within telemedicine's security framework. Thus, this study addresses this gap by extending UTAUT with trust and adaptability constructs [16], [5] and by exploring privacy protection and system reliability, which are central to ICT staff's responsibilities.

TABLE I. SUMMARY OF KEY RELATED STUDIES AND LIMITATIONS

Ref	Study & Focus	Limitation
[5]	Ahmad et al. (2023) ICT readiness in Malaysia	Highlights readiness gaps but lacks a theoretical model
[7]	Rahman et al. (2024) UTAUT for telemedicine (Indonesia)	Focused on general users, not backend system personnel
[8]	Khoo et al. (2023) Clinician adoption barriers in Malaysia	Only includes clinician perspectives; lacks technical staff data
[10]	Marcelo et al. (2022) ICT adoption (Philippines)	Conducted outside Malaysia; cultural/infrastructure context differs
[15]	Niu& Hong(2024) Interoperability in Malaysian telemedicine	Only examining the effect of trust in technology
[16]	Vaddhano & Tulipa (2023) Trust in UTAUT (Thailand)	Investigated trust but excluded ICT worker-specific concerns

III. METHODOLOGY

This study adopts a quantitative, cross-sectional survey design to evaluate the acceptance and perceptions of telemedicine systems among ICT professionals in selected Malaysian public hospitals. The theoretical basis for this research was the Unified Theory of Acceptance and Use of Technology (UTAUT) model, as proposed by Venkatesh et al. [1]. Two additional constructs, Trust in Technology and Adaptability, were integrated into the model based on theoretical findings, as shown in Table I. These two constructs intend to more effectively address the identified research gap and problem, particularly the limited understanding of ICT professionals' acceptance of telemedicine systems implementation in technically complex healthcare environments. These constructs capture critical aspects such as system security reliability, user confidence, and adaptability to evolving digital workflows [17], [18].

In this research, the UTAUT constructs are interpreted using telemedicine security readiness perspectives as follows:

- PE = Performance Expectancy (perceived secure performance benefit)
- EE = Effort Expectancy (secure workflow usability)
- SI = Social Influence (security culture/organizational influence)
- FC = Facilitating Conditions (security-ready infrastructure & support)
- TT = Trust in Technology (trust in system security & reliability)
- AD/A = Adaptability (adaptability to secure digital workflows)

A. Survey Instrument

The data collection tool was a structured questionnaire adapted from previously validated UTAUT-based instruments used in telemedicine and healthcare ICT. The survey was designed to assess six key constructs: Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), Facilitating Conditions (FC), Trust in Technology (TT), and Adaptability (AD/A). Likert-scale questions were presented to gather demographic information on participants' job roles, years of experience in ICT, and institutional affiliations, to contextualize their responses within the healthcare infrastructure.

B. Sampling and Data Collection

The case study for this research targeted ICT professionals supporting, maintaining, or deploying telemedicine systems in Malaysian public hospitals, focusing on the Klang Valley area [Hospital Kuala Lumpur, Hospital Putrajaya, Hospital Kajang, Selayang Hospital, Hospital Canselor Tuanku Muhriz UKM (HCTM)]. These hospitals were selected purposively because they were integrated into the Ministry of Health's Virtual Clinic initiative, which provided a reliable operational context for telemedicine services [4]. A purposive sampling technique was employed to ensure that only participants with relevant experience and involvement in the deployment of the telehealth system were included. The questionnaire was distributed online

using Google Forms, with access shared through hospital ICT units and administrative channels. Participation was entirely voluntary and anonymous. Respondents were informed about the study's goal, the confidentiality of their responses, and their right to withdraw at any time. This study is exploratory and context-specific, involving ICT personnel from selected public hospitals in the Klang Valley. Therefore, findings should be interpreted within this operational context.

Using Cochran's formula [19] with a 95% confidence level and a 5% margin of error, the estimated population of 90 ICT professionals from all selected hospitals yielded 69 responses (≈77% response rate), resulting in a margin of error of approximately ±5.7% at the 95% confidence level. Given the study's targeted sampling frame, high response rate, and exploratory nature, the sample was considered sufficiently representative for statistical analysis and inference [20]. For the data analysis, all obtained responses were compiled and analyzed using SPSS Statistics Version 21.

IV. Hypothesis

Research hypotheses are derived from the research purpose, which aims to examine the key determinants influencing telemedicine acceptance and its impact on the quality of care among Malaysian healthcare professionals. This study selectively examines security-relevant determinants from the extended UTAUT framework rather than testing the complete original UTAUT model. The hypotheses were tested using Pearson correlation and multiple regression analyses, which provide insight into the direction and strength of the relationships between the variables. The development of these relationships is critical for informing the implementation of healthcare settings in selected Malaysian public hospitals. Each hypothesis was evaluated using a separate regression model, based on the specified predictor-outcome relationship. The hypotheses are stated as follows:

- H1: Facilitating Conditions significantly and positively predict Performance Expectancy among healthcare professionals - Reflects the availability of secure technical infrastructure and support mechanisms [21].
- H2: Trust in Technology is positively associated with Performance Expectancy - Implies confidence in the security, reliability, and data protection of telemedicine, which increases professionals' expectations of its usefulness in healthcare delivery [22].
- H3: Adaptability of healthcare professionals is positively related to Satisfaction with telemedicine services - Indicates ICT professionals' adaptability in securing digital healthcare workflows, resulting in higher levels of satisfaction [23].

V. Results and Discussion

The analysis began with descriptive statistics to have a summary of the demographic profile of respondents and their agreement with the survey items. Pearson correlation analysis was used to examine the relationships among constructs. A multiple linear regression analysis test was performed to determine the predictors of ICT staff perceptions of telemedicine system effectiveness, including three hypothesis relationships: FC predicting PE, TT predicting PE, and AD predicting Satisfaction. All statistical procedures were conducted at a 95% confidence level, and assumptions about normality, multicollinearity, and homoscedasticity were checked and met before proceeding with the regression tests. These findings provide empirical insights into how key security-relevant factors, including system usability within secure workflows, trust in system security and reliability, infrastructure readiness, and ICT professionals' adaptability, influence telemedicine security readiness and the adoption of secure telemedicine services.

A. Descriptive Analysis

The responses were from 69, and the demographic distribution showed a balanced gender profile, with 53.6% female and 46.4% male respondents, as in Table II. The age groups were diverse, with the largest proportion being 36–45 years (30.4%), followed by 26–35 years (27.5%) and 18–25 years (20.3%). Fig. 1 shows that the highest institutional participation was from Hospital Canselor Tuanku Muhriz UKM (39.1%), highlighting its significant role in telemedicine adoption. Its partnership with the university makes it more accessible. This diverse respondent base supports the generalizability of findings related to ICT perspectives on telemedicine integration.

TABLE II. Demographic Information

Variable	Mean	Std. Deviation	Category	Frequency	Percentage
Gender	1.536	.5023	Male	32	46.4%
			Female	37	53.6%
Age	2.536	1.0513	18-25	14	20.3%
			26-35	19	27.5%
			36-45	21	30.4%
			46-55	15	21.7%

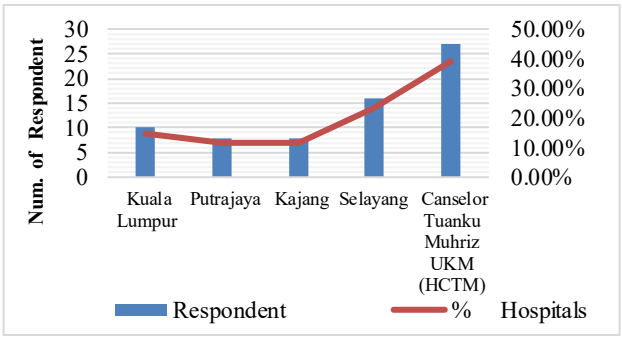

Fig. 1. Participation from ICT professionals.

Fig. 2 represents the Trust in Technology (M = 3.60) and Effort Expectancy (M = 3.60) received the highest mean scores, indicating strong confidence among ICT professionals in the security and reliability of telemedicine systems, which are essential for sustaining secure healthcare services. Social Influence (M = 3.58) and Adaptability (M = 3.58) also had positive attitudes. Performance Expectancy (M = 3.12) and Facilitating Conditions (M = 3.05) were rated comparatively

lower, indicating moderate perceptions of the system's impact on job performance and the sufficiency of infrastructure. These results offer preliminary insight into the readiness of ICT professionals to enable secure telemedicine, highlighting the importance of developing resilient technical infrastructure and performance-based benefits.

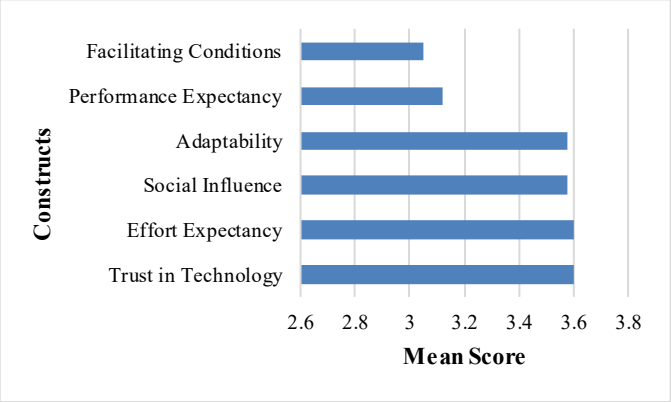

Fig. 2. Telemedicine security readiness profile (n = 69).

Overall, ICT professionals' reported readiness signals in trust and usability, while infrastructure support and perceived performance impact appeared comparatively weaker. As shown in Table III, there is room for strengthening secure telemedicine implementation.

TABLE III. DESCRIPTIVE MEAN SCORES OF TELEMEDICINE SECURITY READINESS CONSTRUCTS

Construct	Mean (M)	Security-readiness interpretation
TT	3.6	Confidence in system security & reliability
EE	3.6	Secure system perceived as usable/easy to operate
SI	3.58	Organizational support/peer influence for secure use
AD/A	3.58	Readiness to adjust to secure workflows/practices
PE	3.12	Moderate perceived impact on job performance
FC	3.05	Moderate adequacy of infrastructure/support (readiness gap)

B. Reliability Analysis

TABLE IV. RELIABILITY SUMMARY OF MEASUREMENT CONSTRUCTS

Construct	Cronbach's α	CITC range	Decision
PE	0.901	0.650–0.871	Retained (α > 0.70)
EE	0.905	0.650–0.871	
TT	0.924	0.650–0.871	
SI	0.972	0.867 – 0.909	
FC	0.972	0.782 – 0.866	
AD	0.972	0.871 – 0.895	

All constructs exceeded the recommended Cronbach's alpha threshold (α > 0.70), as shown in Table IV, indicating high reliability of the survey instrument. Corrected Item-Total Correlation (CITC) values ranged from 0.650 to 0.871, confirming each item's significant contribution to its construct. The results showed minimal variation in alpha-if-item-deleted values (0.972-0.974), confirming that no items required removal. These results validate the instrument's robustness for subsequent analysis.

C. Correlation Analysis

Pearson correlation analysis revealed significant positive relationships among all key constructs, with correlations at $p < 0.01$ (2-tailed). Notably, as in Table V, the strongest relationships were observed between EE and SI ($r = 0.894$), PE and FC ($r = 0.871$), and TT and AD ($r = 0.852$). These results are evidence that secure telemedicine readiness is closely associated with the following:

- Security-ready infrastructure and support (FC) strengthening perceived system benefit (PE)
- Trust in system security and reliability (TT) supporting ICT professionals' readiness to adapt to secure digital workflows (A).

Fig. 3 presents a heatmap of the Pearson correlations reported in Table V. Thus, the correlations suggest that the interconnected roles of usability, organizational influence, infrastructure readiness, and trust are key components in crafting secure telemedicine adoptions flexible and willing to embrace telemedicine technologies tend to report higher satisfaction.

TABLE V. PEARSON CORRELATIONS BETWEEN TELEMEDICINE SECURITY READINESS CONSTRUCTS

Cons.	PE	EE	SI	FC	TT	A
PE	1	.782**	.802**	.871**	.785**	.777**
EE	.782**	1	.894**	.708**	.817**	.779**
SI	.802**	.894**	1	.765**	.791**	.762**
FC	.871**	.708**	.765**	1	.761**	.752**
TT	.785**	.817**	.791**	.761**	1	.852**
A	.777**	.779**	.762**	.752**	.852**	1
**. Correlation is significant at the 0.01 level (2-tailed).						

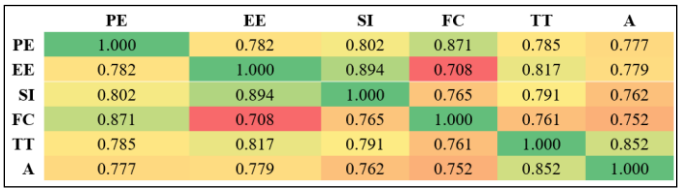

Fig. 3. Pearson correlation heatmap of telemedicine security readiness constructs.

D. Regression Analysis

Multiple regression analysis further supported these findings through three separate predictive models, aligned with the study hypothesis. The regression outcomes are summarized in Table VI. Model 1 revealed that Facilitating Conditions significantly predicted Performance Expectancy ($\beta = 0.483$, $p = 0.007$), underscoring the importance of a security-ready infrastructure, reliable system support, and technical safeguards in shaping ICT professionals' perceptions. Model 2 confirmed that Trust in Technology also positively influenced Performance Expectancy ($\beta = 0.428$, $p = 0.012$). Meanwhile, Model 3

identified Adaptability as a significant predictor of user Satisfaction ($\beta = 0.521$, $p < 0.001$), highlighting its importance in the successful adoption of secured telemedicine systems. Collectively, these findings highlight that a supportive technological environment and adaptable ICT staff are crucial drivers of secure telemedicine adoption.

TABLE VI. MULTIPLE REGRESSION RESULTS FOR TELEMEDICINE SECURITY READINESS.

Model	Dependent Variable	Significant Predictor(s)	Standardized β	*p*-Value
Model 1	Performance Expectancy (PE)	Facilitating Conditions (FC)	0.483	0.007
Model 2	Performance Expectancy (PE)	Trust in Technology (TT)	0.428	0.012
Model 3	Satisfaction	Adaptability (AD/A)	0.521	< 0.001

E. Hypothesis Test

The hypothesis testing results revealed that Facilitating Conditions significantly predicted Performance Expectancy among ICT professionals, strongly supporting H1. In contrast, both Trust in Technology (H2) and Adaptability (H3) significantly predicted Performance Expectancy, while Adaptability showed a strong positive correlation with Performance Expectancy. However, it did not emerge as a significant predictor of Performance Expectancy in the regression models, yet it was significant in predicting satisfaction. These findings suggest that while trust and adaptability are valued, infrastructure and technical support remain the most influential factors in shaping ICT professionals' perceptions of telemedicine effectiveness. Thus, H1 is fully supported, while H2 is supported, and H3 is supported for Satisfaction but not for Performance Expectancy. The hypothesis testing summary is presented in Table VII.

TABLE VII. HYPOTHESES ANALYSIS

Hypothesis	Relationship Tested	Correlation (r)	Regression (β)	*p*-value	Supported?	Addresses Objective
H1	FC → PE	0.871**	0.483	0.007	Yes	Security-ready infrastructure/support boosts perceived usefulness
H2	TT → PE	0.785**	0.428	0.012	Yes	Trust in system security & reliability boosts perceived usefulness
H3	AD → Satisfaction	0.786**	0.521	<0.001	Yes	Adaptability to secure workflows increases satisfaction
*p < 0.01 (2-tailed). (** indicates significant correlation at 0.01 level.)*						

TABLE VIII. TELEMEDICINE ANALYSIS SUMMARY

Evidence (from analysis)	Key finding	Security-readiness implication
Descriptive Statistics (PE, EE, SI, FC, TT, AD)	Mean range: 3.05–3.60; highest means: TT = 3.60, EE = 3.60; lower means: PE = 3.12, FC = 3.05	ICT professionals demonstrate a positive readiness toward secure telemedicine; however, security-ready infrastructure and support, as well as perceived performance benefits, require further strengthening.
Reliability Analysis (23 items)	Overall reliability: Cronbach's Alpha = 0.974	The measurement instrument is robust, supporting confidence in the reported telemedicine security readiness findings.
Correlation Analysis	TT–PE: r = 0.850, AD–Satisfaction: r = 0.786 ($p < 0.01$)	Trust in system security/reliability is strongly linked to perceived usefulness, while adaptability is strongly linked to satisfaction—both are key indicators of readiness.
Regression Model 1	FC → PE: β = 0.483, p = 0.007	Security-ready infrastructure, support, and safeguards significantly strengthen ICT professionals' perception of telemedicine usefulness.
Regression Model 2	TT → PE: β = 0.428, p = 0.012	Higher trust in system security and reliability increases perceived usefulness, supporting the readiness of secure telemedicine.
Regression Model 3	AD → Satisfaction: β = 0.521, $p < 0.001$	ICT professionals' adaptability to secure digital workflows significantly improves satisfaction and supports sustained secure adoption.

Summary in Table VIII outlines the key findings from the analysis, showing strong support for H1 and partial support for H2 and H3. These results suggest that telemedicine success depends not only on usability but also on organizational preparedness to support secure digital healthcare services, aligning with broader telemedicine security governance objectives.

VI. CONCLUSION AND FUTURE WORK

The study provides empirical evidence on the security readiness of telemedicine from the perspectives of ICT professionals supporting telemedicine services in selected public hospitals, particularly in the Malaysian case study. The overall perception was positive, especially for Trust in Technology and Effort Expectancy, indicating that secure telemedicine platforms are generally accepted as reliable and adaptable. However, a similarly low perception of Performance Expenditure and Facilitation Conditions suggests that the perceived benefits of telemedicine and the adequacy of the infrastructure remain areas for improvement. A summary of key results is provided in Table VIII.

The inferential findings further prove the key readiness drivers for secure telemedicine. Whereby, correlation values indicate a strong interrelationship among the constructs, while regression results confirm that security-ready infrastructure and support (Facilitating Conditions) and trust in system security and reliability (Trust in Technology) both contribute to a gradual improvement in perceived usefulness (Performance Expectancy). Additionally, Adaptability also significantly predicts Satisfaction, highlighting the importance of ICT professionals' readiness to operate within a secure digital work process. Collectively, these findings suggest that secure telemedicine adoption depends not only on system usability but

also on organizational preparedness, trusted operations, and workforce adaptability, offering practical direction for robust secure digital healthcare services.

Extended studies in this research area can be conducted by employing a larger, more diverse sample of ICT professionals from various regions and hospital levels across Malaysia, including private and rural health facilities. As this study used correlation and multiple regression for exploratory purposes and with a limited sample size, future studies with larger samples may employ SEM to examine mediation and full model fit. This will make the results more generalizable and allow for comparisons across various healthcare settings. Longitudinal studies are also recommended to quantify how perceptions and uptake patterns evolve.

Moreover, future studies may extend this work by examining telemedicine cybersecurity practices, security governance frameworks, and regulatory compliance models to further strengthen telemedicine security readiness across healthcare systems. Interpreting the impact of cybersecurity, digital literacy, and departmental collaboration on telemedicine deployment would help facilitate a more comprehensive understanding of its success.

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