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Evaluating the Effect of Digital Literacy, Interoperability Capability, Cybersecurity Awareness, Change Fatigue, and Organizational Agility on Smart Hospital Implementation Success

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Abstract

This study aims to analyze the influence of Digital Literacy, Interoperability Capability, Cybersecurity Awareness, Change Fatigue, and Organizational Agility on Smart Hospital Implementation Success. This study employed a quantitative approach using Structural Equation Modeling based on Partial Least Squares (SEM-PLS). Data were collected through questionnaires distributed to 200 medical personnel working in hospitals. The analysis was conducted to evaluate the relationships between the proposed variables and Smart Hospital Implementation Success. The findings reveal that Organizational Agility and Cybersecurity Awareness have a positive and significant effect on Smart Hospital Implementation Success. Organizational Agility emerged as the most influential factor in supporting successful smart hospital implementation. Meanwhile, Digital Literacy showed a significant negative effect, indicating that digital competencies alone are insufficient without adequate organizational readiness and system support. Interoperability Capability did not significantly affect Smart Hospital Implementation Success, suggesting that integration and standardization challenges still exist in healthcare systems. Furthermore, Change Fatigue demonstrated a negative but insignificant influence on smart hospital implementation. The IPMA results also confirmed that Organizational Agility is the highest priority factor that should be strengthened by hospital management. The study concludes that the success of smart hospital implementation is influenced not only by technological aspects but also by organizational adaptability, cybersecurity awareness, and effective change management. Hospitals need to prioritize organizational agility and cybersecurity readiness to ensure sustainable digital transformation in healthcare services.

Keywords: *Smart Hospital, Organizational Agility, Cybersecurity Awareness, Digital Literacy, Change Fatigue, SEM-PLS.*

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INTRODUCTION

Digital transformation in the healthcare sector has evolved from the mere adoption of information technology to the implementation of integrated, adaptive, and intelligent systems, known as smart hospitals. Smart hospitals utilize digital technologies such as integrated information systems, clinical data interoperability, real-time analytics, and process automation to improve service quality, patient safety, and operational efficiency (Sony et al., 2023; Nwobodo-Anyadiegwu et al., 2022). However, the success of smart hospital implementation is not solely determined by technological sophistication but also depends heavily on the readiness of human resources and the organization's ability to sustainably manage digital change.

One of the fundamental factors in the success of a hospital's digital transformation is digital literacy. Digital literacy encompasses not only the technical ability to use digital systems, but also critical understanding, the ability to evaluate information, and a positive attitude toward health technology (Kuek & Hakkennes, 2020; Arias López et al., 2023). In the healthcare context, low digital literacy among healthcare workers can hinder the utilization of digital systems, increase the risk of technology misuse, and reduce the effectiveness of digital innovation (Tegegne et al., 2023). A study by Oh et al. (2021) confirmed that variations in digital literacy levels significantly impact the adoption of health technology, particularly in complex clinical environments. Therefore, digital literacy is seen as a key determinant in the successful implementation of smart hospitals.

In addition to individual capabilities, the success of a smart hospital is also largely determined by interoperability. Interoperability enables different healthcare systems and devices to exchange, integrate, and utilize data consistently and securely (Jaleel et al., 2020). Without adequate interoperability, hospitals risk data fragmentation, service duplication, and reduced clinical decision-making quality. The development of interoperability standards such as Fast Healthcare Interoperability Resources (FHIR) has been shown to improve service integration and operational efficiency (Nan & Xu, 2023). The findings of Bennion et al. (2025) also demonstrate that interoperability, supported by organizational digital capabilities, is a critical foundation for modern healthcare systems.

On the other hand, the increasing digitalization of hospitals also brings increasingly complex information security risks. Cybersecurity awareness is a crucial factor in protecting patient data and maintaining public trust. Studies by Kim (2017) and Chua & Sacopulos (2022) confirm that weak cybersecurity awareness among healthcare workers increases vulnerability to data breaches and cyberattacks. Carreiro et al. (2024) show that innovative approaches such as gamification can significantly improve healthcare workers' cybersecurity awareness. Thus, cybersecurity awareness plays a crucial role in ensuring the sustainability and success of smart hospital implementation.

However, intensive digital transformation also has the potential to cause negative psychological impacts in the form of change fatigue. Change fatigue arises when individuals become exhausted by repeated and rapid organizational changes, ultimately reducing motivation, engagement, and acceptance of innovation (Lv et al., 2025). In the hospital context, change fatigue can hinder the adoption of new digital systems and undermine the success of smart hospital implementation.

To keep pace with these changing dynamics, organizational agility becomes a strategic factor. Organizational agility reflects an organization's ability to respond to change quickly, flexibly, and adaptively (Zeid et al., 2024). Hospitals with high levels of organizational agility tend to have better change readiness, higher staff engagement, and more successful innovation implementation (Kamel et al., 2025; Chansanguan et al., 2025). Therefore, organizational agility has the potential to be a key driver of successful smart hospital implementation. Based on the description, this study aims to evaluate the influence of digital literacy, interoperability capability, cybersecurity awareness, change fatigue, and organizational agility on the success of smart hospital implementation, in order to provide empirical and practical contributions to the development of hospital digital transformation. The novelty of this study lies in its simultaneous integration of five theoretically distinct determinants individual competence (Digital Literacy), system capability (Interoperability Capability), security behavior (Cybersecurity Awareness), psychological dimension (Change Fatigue), and organizational adaptability (Organizational Agility) within a single empirical SEM-PLS model applied to the smart hospital context. Unlike prior studies that typically examine these factors individually or in limited combinations, this study offers an integrative empirical framework that differentiates the relative contribution of each determinant and provides new evidence regarding the dominant role of Organizational Agility over individual-level competencies in determining Smart Hospital Implementation Success.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Digital Literacy and Smart Hospital Implementation Success

The ability of health workers to understand and utilize digital technology is a key prerequisite for intelligent hospital transformation. High digital literacy allows health workers to adapt to digital systems, increase the accuracy of technology use, and support the integration of clinical and administrative processes (Kuek & Hakkennes, 2020; Arias López et al., 2023).

Theoretically, this relationship is grounded in the Technology Acceptance Model (TAM), which posits that perceived ease of use and usefulness both enhanced by higher digital competence are key antecedents of technology adoption behavior. Digitally literate healthcare workers are also better positioned to evaluate clinical information systems critically, adapt to new digital workflows efficiently, and contribute to evidence-based decision making in integrated hospital

environments (Oh et al., 2021). Thus, digital literacy is estimated to have a positive influence on the success of smart hospital implementation.
H_1: Digital literacy has a positive influence on smart hospital implementation success.

Interoperability Capability and Smart Hospital Implementation Success

Seamless information system integration and data exchange are at the heart of a smart hospital. Interoperability enables continuity of service, improved clinical decision-making quality, and operational efficiency (Jaleel et al., 2020; Nan & Xu, 2023). From a theoretical standpoint, interoperability is anchored in information systems theory and systems thinking, which posit that the overall performance of an integrated system depends on coherent information exchange across its constituent components.

In healthcare, seamless data flow between clinical systems, devices, and platforms reduces information silos, supports faster clinical decision making, and minimizes service duplication all of which are hallmarks of a well-functioning smart hospital (Bennion et al., 2025). Therefore, robust interoperability is expected to enhance the success of smart hospital implementation.
H_2: Interoperability capability has a positive influence on smart hospital implementation success.

Cybersecurity Awareness and Smart Hospital Implementation Success

The success of a smart hospital depends heavily on the security and trust in digital systems. High cybersecurity awareness among healthcare professionals can minimize security risks and increase trust in digital systems (Kim, 2017; Chua & Sacopulos, 2022). Theoretically, this relationship is explained by Protective Motivation Theory (PMT), which posits that individuals who perceive security threats as serious and believe in their capacity to take protective action are more likely to engage in security-compliant behaviors.

In a smart hospital environment characterized by the Internet of Medical Things (IoMT), electronic health records, and real-time data exchange, healthcare workers with heightened cybersecurity awareness function as a critical human layer of defense against data breaches and cyberattacks (García-Pérez et al., 2022). Therefore, cybersecurity awareness is expected to contribute positively to the successful implementation of a smart hospital.
H_3: Cybersecurity awareness has a positive influence on smart hospital implementation success.

Change Fatigue and Smart Hospital Implementation Success

Continuous digital change has the potential to cause change fatigue, which can reduce the acceptance and effectiveness of new system implementation (Lv et al., 2025). Grounded in Conservation of Resources

(COR) theory, change fatigue emerges when repeated organizational demands deplete an individual's psychological and emotional resources, resulting in withdrawal, reduced engagement, and resistance to further change (Chansanguan et al., 2025).

In smart hospital implementation contexts where simultaneous changes to clinical workflows, administrative processes, and technology platforms are common, the cumulative burden placed on healthcare workers can erode their commitment to new digital initiatives over time. Therefore, change fatigue is expected to negatively impact the success of smart hospital implementation.

H_4: Change fatigue has a negative effect on smart hospital implementation success.

Organizational Agility and Smart Hospital Implementation Success

Agile hospital organizations are able to respond to technological changes adaptively and sustainably. Organizational agility supports change readiness, cross-unit collaboration, and the success of digital innovation (Zeid et al., 2024; Kamel et al., 2025). Theoretically, organizational agility is rooted in the dynamic capabilities framework, which argues that organizations capable of sensing environmental changes, seizing emerging opportunities, and reconfiguring internal resources are better positioned to sustain performance under conditions of rapid technological change.

In healthcare digital transformation, this translates to hospitals that can rapidly reallocate human resources, adapt governance structures, and revise clinical protocols in response to evolving technology demands, thereby reducing implementation barriers and accelerating the transition to smart hospital operations (Rabiei et al., 2025). Therefore, organizational agility is expected to have a positive influence on the success of smart hospital implementation.

H_5: Organizational agility has a positive influence on smart hospital implementation success.

METHOD

This study used a quantitative approach with an explanatory research design, which aims to test the causal relationships between latent constructs in the research model. The research design used was cross-sectional. The population in this study were healthcare workers working in hospitals that have or are currently implementing a smart hospital system, including the use of hospital information systems, electronic medical records, and digital technology supporting clinical and administrative services.

The sampling technique used was purposive sampling, with respondent criteria including: (1) healthcare workers directly involved in the use of the hospital's digital system, (2) having a minimum of one year of service, and (3) having experience with digital-based system changes in hospitals. The use of purposive sampling was considered appropriate to ensure that respondents had knowledge and experience relevant to the

research context (Hair et al., 2021). The measurement instrument was developed by adapting established items from prior empirical studies. Indicators for Digital Literacy were adapted from Kuek and Hakkennes (2020) and Oh et al. (2021); Interoperability Capability items from Jaleel et al. (2020) and Nan and Xu (2023); Cybersecurity Awareness indicators from Kim (2017) and Chua and Sacopulos (2022); Change Fatigue items from Lv et al. (2025); Organizational Agility indicators from Zeid et al. (2024); and Smart Hospital Implementation Success items from Sony et al. (2023) and Nwobodo-Anyadiegwu et al. (2022).

All items were rated on a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). Prior to full data collection, a content validity review was conducted with two academic experts in healthcare management and information systems to verify item relevance and clarity, with minor wording adjustments made accordingly. Data were collected online over four weeks, and all completed responses were verified for completeness before analysis. Statistical analysis was performed using SmartPLS 4.0.

RESULT

Respondent Profile

To provide a comprehensive overview of the characteristics of the respondents involved in this study, a respondent profile analysis was conducted based on several relevant demographic and socioeconomic characteristics. The profile is important for understanding the background of the 200 respondents and provides contextual information for interpreting the subsequent research findings. The distribution of respondents according to the identified characteristics is presented in Table 1.

Table 1. Respondent Profile (N = 200)

Charakteristic	Category	Frequency (n)	Percent (%)
Gender	Male	133	66,5
	Female	67	33,5
Age	< 25 years	14	7,0
	25–35 years	74	37,0
	36–45 years	70	35,0
	> 45 years	42	21,0
Final Education	Diploma 3	31	15,5
	Bachelor's Degree	87	43,5
	Master's Degree	82	41,0
Profession	Doctors	76	38,0
	Nurses	50	25,0
	Midwives	29	14,5
	Other Health Workers	45	22,5
Years of service	1–3 years	51	25,5
	4–6 years	60	30,0
	7–10 years	51	25,5
	> 10 years	38	19,0
Work unit	Outpatient Care	34	17,0
	Inpatient Care	44	22,0

	Emergency Room	39	19,5
	Administration	27	13,5
	Other	46	23,0

Based on the Respondent Profile Table, this study involved 200 respondents consisting of 133 male respondents (66.5%) and 67 female respondents (33.5%). In terms of age, the majority of respondents were in the 25–35 years age range, amounting to 74 people (37.0%), followed by the 36–45 years age group, amounting to 70 people (35.0%), those aged over 45 years, amounting to 42 people (21.0%), and those aged under 25 years, amounting to 14 people (7.0%). This shows that most respondents were in their productive age who generally had work experience and adequate understanding of technology implementation in the hospital environment.

Based on education level, the majority of respondents had a bachelor's degree (87 people) (43.5%), followed by a master's degree (82 people) (41.0%), and a diploma (3) (3). In terms of profession, the largest group was doctors (76 people) (38.0%), followed by nurses (50 people) (25.0%), other health workers (45 people) (22.5%), and midwives (29 people) (14.5%). Based on length of service, the majority of respondents had 4–6 years of work experience (60 people) (30.0%), while 51 respondents (25.5%) had 1–3 years and 7–10 years of work experience, respectively, and 38 respondents (19.0%) had more than 10 years of work experience. Based on work units, the majority of respondents came from other categories (46 people) (23.0%), followed by inpatients (44 people) (22.0%), the emergency department (39 people) (19.5%), outpatients (34 people) (17.0%), and administration (27 people) (13.5%). This composition indicates that respondents came from various professional backgrounds and work units, thus providing a comprehensive picture of the implementation of smart hospitals in the hospital environment.

Outer Model

The evaluation of the outer model was conducted to assess the quality of the measurement model used in this study. This evaluation focuses on examining the validity and reliability of the constructs through indicator loadings, Average Variance Extracted (AVE), and composite reliability. The assessment aims to ensure that each indicator adequately represents its respective construct and that the measurement instruments demonstrate satisfactory levels of consistency and convergent validity. The results of the outer model assessment are presented visually in Figure 1 and summarized in Table 2.

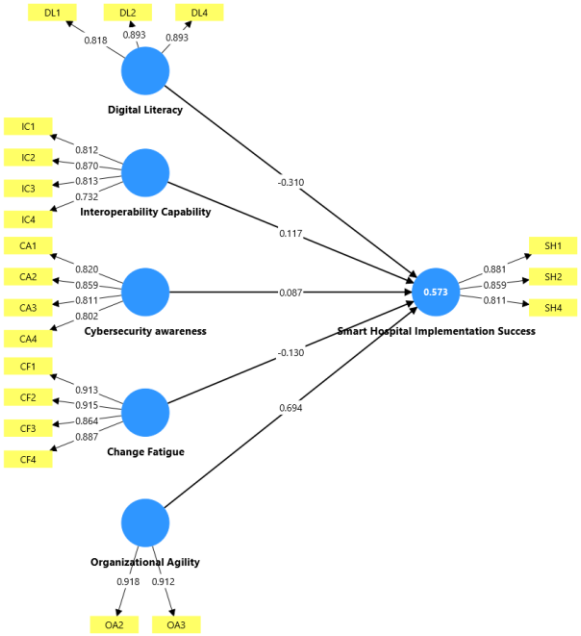


Figure 1. Outer Model

Figure 1 illustrates the relationships between the latent constructs and their respective measurement indicators, including the outer loadings obtained from the PLS-SEM analysis. These results provide an initial assessment of the extent to which each indicator contributes to measuring its corresponding construct.

Table 2. Evaluation Results of Measurement Model and Structural Model

Variable	Indicator	Outer Loading	AVE	Composite Reliability (rho_c)	VIF	R-square	Q-square
Cybersecurity Awareness (CA)	CA1	0.820	0.678	0.894	1.805	-	-
	CA2	0.859			2.145		
	CA3	0.811			1.755		
	CA4	0.802			1.808		
Change Fatigue (CF)	CF1	0.913	0.801	0.942	3.156	-	-
	CF2	0.915			2.984		
	CF3	0.864			2.801		
	CF4	0.887			2.973		
Digital Literacy (DL)	DL1	0.818	0.754	0.902	1.931	-	-
	DL2	0.893			2.067		
	DL4	0.893			1.990		
Interoperability Capability (IC)	IC1	0.812	0.653	0.882	2.077	-	-
	IC2	0.870			1.984		
	IC3	0.813			1.573		
	IC4	0.732			1.666		
Organizational Agility (OA)	OA2	0.918	0.837	0.911	1.835	-	-
	OA3	0.912			1.835		
Smart Hospital Implementation Success (SH)	SH1	0.881	0.724	0.887	2.019	0.573	0.518
	SH2	0.859			1.777		
	SH4	0.811			1.641		

Table 2 presents the detailed results of the measurement model evaluation, including indicator loadings, Average Variance Extracted (AVE), and composite reliability. These values are used to determine whether the measurement model satisfies the established criteria for validity and reliability.

The assessment of the research model followed the two-step procedure recommended by Hair et al. (2021), beginning with the evaluation of the measurement model (outer model) before proceeding to the structural model (inner model). The outer loading results show that all indicators have loading values above 0.70, thus all items are declared valid in representing their respective constructs. The indicator in the Change Fatigue variable has the highest loading, namely CF2 of 0.915, which indicates a very strong ability to explain the construct. Meanwhile, the IC4 indicator in the Interoperability Capability variable has the lowest loading value of 0.732, but is still above the recommended minimum limit. Thus, all indicators are worthy of being retained in the research model because they have met the requirements for convergent validity.

The results of validity and reliability testing indicate that all constructs meet the required criteria. Cronbach's Alpha and Composite Reliability values for all variables are above 0.70, indicating that the instrument has a good level of internal consistency and reliability. Furthermore, the Average Variance Extracted (AVE) values for all variables are above 0.50, indicating that the constructs are able to explain more indicator variance than measurement error. The Change Fatigue variable has the highest reliability and AVE values, indicating that this construct has very strong consistency and explanatory power for indicators.

The Variance Inflation Factor (VIF) test results show that all indicators have VIF values below 5, thus ensuring the model is free from multicollinearity issues. This indicates that there is no excessive correlation between indicators within the research constructs. The highest VIF value is found in indicator CF1 at 3.156, but it is still within safe limits. Thus, all indicators can be used in further analysis without causing bias due to multicollinearity.

The R-square value of 0.573 indicates that the variables Cybersecurity Awareness, Change Fatigue, Digital Literacy, Interoperability Capability, and Organizational Agility are able to explain 57.3% of the variability in Smart Hospital Implementation Success, while the remaining 42.7% is explained by other variables outside the research model. This value indicates that the model's explanatory power is in the moderate to strong category. The adjusted R-square value of 0.562 also indicates that the model remains stable after being adjusted for the number of predictor variables used.

The Q^2predict value of 0.518 indicates that the model has good predictive relevance in predicting Smart Hospital Implementation Success. Because the Q^2 value is greater than zero, the model is considered to have relevant predictive ability and is suitable for use in explaining the relationships between variables in the study. Furthermore, the RMSE value of 0.706 and MAE of 0.511 indicate that the model's prediction error level is still within the acceptable range.

Table 3. HTMT

	Change Fatigue	Cybersecurity awareness	Digital Literacy	Interoperability Capability	Organizational Agility	Smart Hospital Implementation Success
Change Fatigue						
Cybersecurity awareness	0.095					
Digital Literacy	0.796	0.086				
Interoperability Capability	0.667	0.127	0.827			
Organizational Agility	0.181	0.272	0.152	0.254		
Smart Hospital Implementation Success	0.107	0.287	0.089	0.148	0.896	

The HTMT values for all construct pairs were below the threshold of 0.90, thus concluding that the model met discriminant validity. This indicates that each variable in the study has distinct characteristics and is able to clearly measure different concepts. The highest HTMT value was found in the relationship between Organizational Agility and Smart Hospital Implementation Success at 0.896, indicating a fairly strong relationship but still within acceptable limits. Having confirmed that the measurement model satisfies convergent validity, internal consistency reliability, and discriminant validity criteria, the analysis proceeded to evaluate the structural model, examining effect sizes (f-square), predictive relevance (Q-square), path coefficient significance, and IPMA results in relation to the study's research objectives.

Inner Model

The evaluation of the inner model was conducted to examine the structural relationships among the latent constructs in the proposed research model. This assessment aims to determine the strength and significance of the relationships between the constructs and to evaluate the extent to which the exogenous constructs explain the endogenous constructs. The analysis includes the assessment of the structural model and effect size (f^2) to identify the contribution of each exogenous construct to the corresponding endogenous construct. The results of the inner model evaluation are presented in Figure 2 and Table 4.

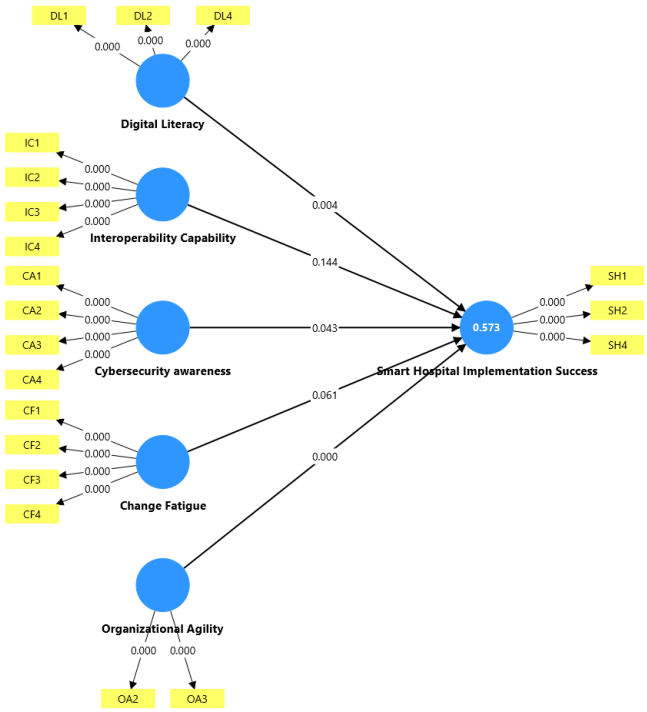


Figure 2. Inner Model

Figure 2 illustrates the structural relationships among the latent constructs examined in this study, including the path coefficients that indicate the direction and strength of the hypothesized relationships. The figure provides an overview of the proposed structural model and the relationships tested using the PLS-SEM approach.

Table 4. F-Square

	f-square
Change Fatigue -> Smart Hospital Implementation Success	0.020
Cybersecurity awareness -> Smart Hospital Implementation Success	0.017
Digital Literacy -> Smart Hospital Implementation Success	0.091
Interoperability Capability -> Smart Hospital Implementation Success	0.016
Organizational Agility -> Smart Hospital Implementation Success	1.017

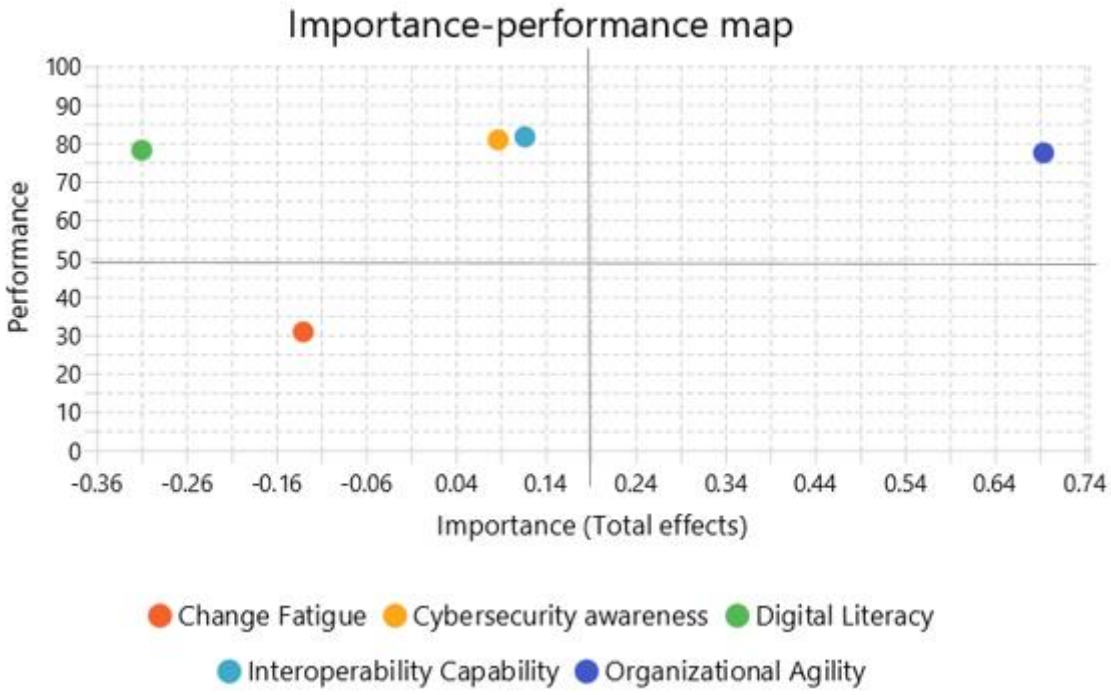
The f-square results show that Organizational Agility has the largest influence on Smart Hospital Implementation Success with a value of 1.017, which is included in the very large effect category. Meanwhile, Digital Literacy has a small to moderate influence with a value of 0.091. The variables Change Fatigue, Cybersecurity Awareness, and Interoperability Capability have f-square values below 0.02, so their influence is considered small on Smart Hospital Implementation Success. These findings indicate that Organizational Agility is the most dominant variable in the research model.

Table 5. Hypothesis Testing

Hypothesis	Path	Original Sample (O)	T Statistics	P Values	Result
H1	Digital Literacy → Smart Hospital Implementation Success	-0.310	2.634	0.004	Rejected
H2	Interoperability Capability → Smart Hospital Implementation Success	0.117	1.063	0.144	Rejected

H3	Cybersecurity Awareness → Smart Hospital Implementation Success	0.087	1.721	0.043	Accepted
H4	Change Fatigue → Smart Hospital Implementation Success	-0.130	1.551	0.061	Rejected
H5	Organizational Agility → Smart Hospital Implementation Success	0.694	12.161	0.000	Accepted

IPMA



Gambar 4. IPMA Map

DISCUSSION

The results of the hypothesis testing indicate that Organizational Agility is the most influential factor in the successful implementation of smart hospitals. This finding is further strengthened by the results of the Importance-Performance Map Analysis (IPMA), which places Organizational Agility as the variable with the highest level of importance compared to other variables. This condition indicates that the organization's ability to adapt to changes in technology, work processes, and healthcare service demands is a strategic factor in supporting the transformation of hospitals into smart hospitals. This finding is relevant to the characteristics of the study respondents, who were dominated by healthcare workers aged 25–45 years (72%) and with 4–10 years of service (55.5%). This group is a workforce that is in the productive phase and actively facing changes in the digital-based healthcare system, thus requiring an adaptive organization to support the change process. Descriptively, the Organizational Agility indicators obtained high scores, indicating that respondents assessed the hospital as having good adaptability to change. These results are in line with research by Zeid et al. (2024) which stated that organizational agility increases readiness for

change in healthcare workers. Kamel et al. (2025) also found that organizational agility contributes to the readiness of healthcare workers to face organizational change. In the context of hospital digital transformation, Chansanguan et al. (2025), Lim et al. (2025), and Rabiei et al. (2025) explain that organizational agility is a key enabler that allows organizations to respond quickly to technological changes and healthcare service needs, thereby increasing the success of smart hospital implementation. This finding also supports Sony et al. (2023) who positioned organizational readiness and adaptability as critical factors for the successful implementation of Healthcare 4.0.

The study also showed that Cybersecurity Awareness positively impacted the success of smart hospital implementation. Descriptive statistics showed that respondents had a relatively high level of cybersecurity awareness. This is understandable considering that the majority of respondents were healthcare professionals, consisting of doctors (38%), nurses (25%), midwives (14.5%), and other healthcare workers (22.5%) who interact daily with patient data and hospital information systems. In a smart hospital environment that relies on data integration, the Internet of Medical Things (IoMT), and electronic medical records, information security awareness is a primary need. IPMA results indicate that Cybersecurity Awareness has a high level of performance, making it a strength that hospital management needs to maintain. This finding aligns with Chua and Sacopulos (2022), who explain that increased cybersecurity awareness can minimize the risk of data leaks and digital attacks on healthcare organizations. Kim (2017) also emphasized that healthcare workers who understand digital security tend to be better prepared to use technology-based healthcare systems securely. Research by Carreiro et al. (2024) shows that increased cybersecurity awareness can improve healthcare workers' compliance with digital security procedures. In addition, García-Pérez et al. (2022) explained that cybersecurity is an important foundation in building the resilience of digital health systems and supporting the success of hospital digital transformation.

On the other hand, Digital Literacy did not show a significant positive influence on the success of smart hospital implementation. This finding is interesting because based on the respondent profile, the majority had a high level of education, namely a bachelor's degree (43.5%) and a master's degree (41%), which theoretically supports a good level of digital literacy. Descriptive statistics also show that Digital Literacy received a relatively high rating. However, the results of structural testing indicate that an individual's ability to use digital technology does not necessarily directly increase the success of a smart hospital. This condition indicates that the success of technology implementation is not only determined by individual abilities, but is also influenced by organizational readiness, policy support, system integration, and a supportive work environment. This finding is in line with Arias López et al. (2023) who stated that digital literacy is an important determinant in modern health systems, but its effectiveness is influenced by the

organizational context. Tegegne et al. (2023) also explained that the digital literacy of healthcare workers is influenced by various factors such as work experience, training, and organizational support. Kuek and Hakkennes (2020) found that healthcare workers with high digital skills did not necessarily demonstrate optimal acceptance of information systems if the systems were deemed inappropriate for their work needs. Furthermore, Oh et al. (2021) demonstrated that digital literacy is multidimensional and influenced by both individual and environmental characteristics. These findings are supported by Alotaibi et al. (2025), who stated that improving digital capabilities requires organizational intervention and system support to have a tangible impact on hospital digital transformation. A critical interpretation of the significant negative direction of the Digital Literacy coefficient suggests that healthcare workers with higher digital competence may develop a heightened awareness of system limitations, identifying integration gaps, usability deficiencies, or functional inadequacies in existing smart hospital platforms that do not yet align with their professional expectations. This elevated critical perspective may generate dissatisfaction and resistance rather than adoption enthusiasm, particularly when organizational digital infrastructure lags behind individual competence levels. This explanation is consistent with Kuek and Hakkennes (2020), who found that digitally skilled staff hold higher expectations for system quality and are more likely to express dissatisfaction when information systems are perceived as insufficient for their professional needs. Consequently, Digital Literacy must be accompanied by a robust, well-integrated, and user-centered digital ecosystem within the hospital to translate individual competence into collective implementation success.

Furthermore, Interoperability Capability has not shown a significant influence on the success of smart hospital implementation. However, IPMA results indicate that this variable has a fairly good level of performance and therefore remains an aspect that needs to be maintained. The insignificant influence of interoperability may be due to the complexity of implementing health system integration, which requires cross-unit coordination, compliance with data standards, and technological infrastructure readiness. The profile of respondents from various work units such as inpatient care (22%), emergency department (19.5%), outpatient care (17%), administration (13.5%), and other units (23%) indicates that the need for information integration between units is indeed very high, but the benefits of interoperability may not be felt equally by all healthcare workers. Jaleel et al. (2020) explain that interoperability is a key foundation in smart healthcare because it enables data exchange between devices and health systems. However, Nan and Xu (2023) emphasize that interoperability requires data standards readiness and strong regulatory support to provide optimal benefits. Bennion et al. (2025) also found that many healthcare organizations still face obstacles in comprehensively implementing interoperability standards, resulting in a less significant impact on healthcare services. This finding aligns with Duncan et al. (2022) who

stated that interoperability is a crucial dimension of hospital digital maturity, but its implementation requires a gradual and ongoing process. An additional interpretation is that Interoperability Capability may exert its effects on smart hospital outcomes primarily through indirect pathways rather than a direct one, potentially mediated by organizational readiness or digital infrastructure maturity. Healthcare workers may perceive the benefits of interoperability mainly through system-wide coordination improvements that accumulate gradually and depend on broader organizational enablers such as policy support, cross-unit governance, and technology standardization. Furthermore, uneven exposure to interoperability functions across clinical units and ongoing challenges in complying with health data standards may have attenuated the direct effect observed in this study. Future research is encouraged to explore the indirect and conditional pathways through which interoperability contributes to smart hospital success.

Meanwhile, Change Fatigue was found to have a negative influence on the success of smart hospital implementation, although the effect was not yet statistically significant. The IPMA results indicate that Change Fatigue is an area that requires special attention from hospital management. This finding can be explained by the characteristics of respondents, most of whom are in the productive age group and are actively involved in various work system changes resulting from digital transformation. Smart hospital implementation often requires changes to work procedures, the use of new technologies, and adjustments to different service flows from before. If these changes occur continuously without adequate support, healthcare workers have the potential to experience change fatigue. Lv et al. (2025) explain that change fatigue can reduce the motivation, engagement, and readiness of healthcare workers to accept organizational change. Chansanguan et al. (2025) also emphasize that the success of hospital digital transformation requires an effective change management strategy to avoid resistance or organizational fatigue. Lim et al. (2025) found that healthcare workers' readiness to face change is strongly influenced by organizational communication, leadership support, and employee involvement in the transformation process. Although the statistical effect of Change Fatigue did not reach significance in this study, the negative direction of the coefficient is practically meaningful and warrants managerial attention. Change fatigue has the potential to become a serious organizational barrier when digital transformation is implemented continuously without adequate communication, structured training, empathetic leadership, and workload adjustment mechanisms. In particular, when healthcare workers are subjected to multiple concurrent changes transitioning to electronic medical records, adopting clinical decision support systems, and adapting to revised administrative workflows the cumulative burden may gradually erode motivation and diminish readiness for further transformation. Hospital management should therefore proactively monitor fatigue indicators and implement change pacing strategies to

prevent Change Fatigue from becoming a significant impediment to long-term smart hospital implementation success.

Referring to the explanation above, the research results show that the success of smart hospital implementation is determined more by organizational factors than individual factors. This is reflected in the high influence of Organizational Agility and the importance of Cybersecurity Awareness, while Digital Literacy and Interoperability Capability have not shown a significant influence. The IPMA results further emphasize that Organizational Agility is a top priority that needs to be improved by hospital management, while Cybersecurity Awareness and Interoperability Capability need to be maintained. On the other hand, Change Fatigue must be managed seriously to prevent it from becoming a barrier to digital transformation. These findings support the Healthcare 4.0 conceptual framework proposed by Sony et al. (2023) and are in line with the smart hospital study by Rabiei et al. (2025), which emphasizes that successful digital hospital transformation requires a combination of organizational readiness, digital security, system interoperability, human resource capabilities, and sustainable change management.

CONCLUSION

This study contributes both theoretical and practical insights to the growing literature on smart hospital implementation. The findings reveal that Organizational Agility is the most dominant factor in determining Smart Hospital Implementation Success, underscoring a central theoretical implication: the success of healthcare digitalization is fundamentally an organizational challenge rather than a purely technological one. An organization's capacity to adapt to change, sense emerging technological opportunities, and reconfigure operational processes is the cornerstone of sustainable hospital digital transformation. Furthermore, Cybersecurity Awareness also has a positive influence on the success of smart hospital implementation, so healthcare workers' awareness of data security and digital systems needs to be continuously strengthened. On the other hand, Digital Literacy shows a negative influence, indicating that individual digital skills alone are insufficient without adequate organizational and system support. Interoperability Capability has not shown a significant influence, so information system integration and standardization remain challenges in hospitals. Meanwhile, Change Fatigue shows a negative influence, indicating that change fatigue has the potential to hinder the digital transformation process. The IPMA results further reinforce that Organizational Agility is a top priority that needs to be improved, while Cybersecurity Awareness and Interoperability Capability need to be maintained. Conversely, Change Fatigue requires more attention to prevent it from hindering healthcare workers' readiness to face technological change.

This study has several limitations: it used only a quantitative questionnaire-based approach, was conducted in a specific hospital context, and employed a cross-sectional design, which means it cannot

adequately describe long-term organizational change. Furthermore, this study is limited to a few variables, leaving other factors such as digital leadership, organizational culture, and technology readiness unanalyzed. Therefore, further research is recommended to use a mixed methods approach, expand the scope of respondents to various hospital types, and include other relevant variables for more comprehensive research results.

The managerial implications of this research suggest that hospital management should consider several actionable directions. First, to strengthen Organizational Agility, hospitals should establish dedicated digital transformation task forces or agile governance teams comprising representatives from clinical, administrative, and IT units, empowered to respond rapidly to technology challenges and facilitate iterative improvements to smart hospital systems. Periodic agility assessments and flexible resource allocation mechanisms should be institutionalized within the hospital's strategic planning cycle. Second, to sustain Cybersecurity Awareness, hospitals should implement structured cybersecurity training programs for all healthcare personnel, including periodic incident-response simulations, phishing awareness drills, and patient data privacy workshops, supported by clear security protocols and organizational reporting mechanisms. Third, information system integration and data standardization should be pursued through phased interoperability roadmaps aligned with established health data standards, ensuring that cross-unit data exchange becomes progressively more seamless over time. Fourth, to mitigate Change Fatigue, management should adopt change pacing strategies, ensuring that digital initiatives are introduced with adequate lead time, transparent communication, and continuous mentoring support. A participatory approach that involves healthcare workers in the co-design of digital workflows will help reduce resistance and build sustained commitment to the hospital's digital transformation journey.

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