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Assessment of digital transformation levels in hospitals: A case study of Hanoi, Vietnam

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Abstract: This study assesses the level of digital transformation in hospitals in Hanoi, Vietnam, providing a comprehensive overview of the current state of digital technology adoption in healthcare. The results indicate that most hospitals are at the "Practitioner" level, reflecting progress in technology implementation but still facing many shortcomings and inconsistencies. The evaluation model is based on five key factors: "Strategy," "Customer experience," "Information Systems and technological infrastructure," "People and culture," and "Operations". The "Strategy" factor has the greatest impact, highlighting the importance of leadership awareness, strategic integration, and investment in IT infrastructure in driving digital transformation. Following this are the factors of "Information systems and technology," "People and culture," "Customer experience," and "Operations." The study also identifies gaps in technology infrastructure and workforce training, providing solutions to improve the level of digital transformation and enhance the quality of healthcare services to meet development needs in the context of globalization.

Keywords: Digital transformation, level of digital transformation, hospital, digital transformation in hospitals.

1. Introduction

In the context of the rapid development of the Fourth Industrial Revolution, digital transformation has become an inevitable global trend, impacting various sectors, driving innovation, and enhancing the competitiveness of organizations and nations. In Vietnam, digital transformation is a government priority. On June 3, 2020, the Prime Minister signed Decision No. 749/QD-TTg approving the national digital transformation program for 2025, with a vision to 2030, emphasizing the integration of digital technology into operations and services to improve efficiency, reduce costs, and enhance service quality. Resolution No. 20-NQ/TW of the 6th Plenum of the 12th Central Committee on "Strengthening the Protection, Care, and

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Improvement of People's Health in the New Situation" and Directive No. 16/CT-TTg, dated May 4, 2017, on "Enhancing the Capacity to Approach the Fourth Industrial Revolution," are important leverage points for the Vietnamese healthcare sector to make breakthroughs in management, healthcare, and accelerating digital transformation, thereby building a smart healthcare system.

However, in practice, the implementation of digital transformation activities in hospitals still faces numerous challenges, with varying degrees of digital transformation across different aspects of hospital operations. Information security and cybersecurity measures are not yet implemented uniformly, and digital transformation faces challenges due to a lack of resources, resistance from staff, and a lack of strategic thinking in applying digital transformation to hospital management. This study clarifies the current level of digital transformation in hospitals and proposes solutions to enhance positive impacts, minimize negative effects, and improve the effectiveness of digital transformation efforts.

Based on the research, appropriate solutions will be proposed to promote positive impacts and enhance the effectiveness of digital transformation in hospitals. The authors identify three main points: First, there is no study evaluating the level of digital transformation in hospitals in Hanoi, which represents a significant research gap. Second, current studies mainly list the influencing factors without delving deeply into their impacts on digital transformation in hospitals. Thirdly, there are many studies on evaluating digital transformation in businesses in Vietnam, but no research using the AHP model has been published.

2. Research overview

2.1. Digital transformation

Digital transformation impacts management, operations, and business, enhancing accessibility and work efficiency. This process creates a crisis, deeply affecting organizations and members, extending to healthcare, administration, and politics (Dörner & Rundel, 2021). Research on digital transformation attracts attention, but limitations and challenges still exist (Kraus et al., 2022).

Digital transformation in developed economies is a strategy to optimize government structures and enhance business competitiveness. The Vietnamese government promotes digital transformation, issuing Resolution No. 52-NQ/TW (2019) as the foundation for the national strategy (The Politburo, 2019), and establishing the National Committee on Digital Transformation (2021) to oversee and coordinate nationwide digital transformation activities (Prime Minister, 2021).

Ulas (2019) argues that digital transformation has changed job creation, income strategies, and flexible management models, while still focusing on optimizing processes and reducing costs (Ash & Burn, 2003). Tran (2020) states that digital transformation maximizes benefits and requires adaptation to new business models. Aagaard (2019) emphasizes the importance of embracing emerging digital trends and building a company culture that fits the digital environment. Vial (2019) notes that successful digital transformation requires strong leadership commitment, active employee participation, and an innovative environment, along with a clear strategic vision from management (Kane et al., 2015).

2.2. Degree of digital transformation

Digital transformation (DT) is accelerating due to advancements in information technology and the demand for sharing and analyzing research data, demonstrated through the use of digital tools at every stage of research, from data collection and management (Borgman, 2015) to analysis, publication, and collaboration (Neylon & Wu, 2009).

DT not only changes research methods but also opens up opportunities for international collaboration and scientific innovation (OECD, 2015). OECD (2022) used a combination of qualitative, quantitative, and comparative methods to develop a model to assess the level of digital transformation in organizations, categorizing them into five levels: initiation, progression, completion, leadership, and aspiration.

Merdin (2022) developed a model to assess digital transformation through seven factors: strategy, customers, employees, processes, technology, organizational culture, and innovation, which was validated using exploratory factor analysis (EFA). Thordsen (2020) provided a framework to measure and improve digital transformation in organizations.

Thordsen et al. (2020) combined qualitative and comparative methods to emphasize the importance of assessing digitization quality in companies based on factors like products, customers, operations, technology, and leadership.

Lai (2019) used SWOT analysis to assess digital transformation in small and medium-sized enterprises in the manufacturing sector, finding that while these businesses excel at using digital technology to optimize production, they face challenges related to finance, human resources, and unclear digital transformation strategies.

2.3. Digital transformation in healthcare

Digital transformation in healthcare is an inevitable trend that helps improve efficiency, quality, and customer experience. Notably, digital transformation improves access to healthcare services for people in remote areas and those facing financial difficulties through electronic health systems, mobile applications, and online platforms (Topol, 2019).

Smart medical devices enable accurate diagnosis and remote health monitoring, reducing hospital visits. AI and Big Data help improve analysis and provide recommendations for patient care. Esteva (2017) shows that AI can match or surpass medical experts in diagnosing skin cancer from images, reducing errors and improving early detection.

The Internet of Things (IoT) plays a key role in monitoring health through wearable devices and sensors, supporting remote healthcare (Islam et al., 2015). IoT devices like blood pressure monitors and glucose meters enable continuous monitoring and data transmission, allowing timely medical intervention, especially for chronic diseases (Sicari et al., 2015).

However, Data security and patient privacy are important issues (Kruse et al., 2017). Data security breaches can severely affect patient trust (McLeod & Dolezel, 2018), and the technology gap between urban and rural healthcare facilities is also a major challenge.

Successful digital transformation requires collaboration between healthcare, management, technology, and science to develop policies, infrastructure, and train healthcare professionals to use new digital tools.

3. Theoretical basis and research hypothesis

According to Rossman's research model (2018), digital transformation includes five criteria: digital strategy, leadership culture, digital marketplace, logistics power, and technological capability. Blake Morgan's study (2020) identifies 11 factors influencing the success of digital transformation, including customers, organizational structure, change management, leadership intent, technological readiness, data integration, logistics and supply chain, data security, product development, data digitization and process digitization, and personalization. The TOE model (Tornatzky & Fleischer, 1990) consists of three factors: Technology, Organization, and Environment. Based on these studies and influencing factors, the authors' team developed an evaluation model consisting of five criteria: Strategy, Customer experience, Information systems and technological infrastructure, People and culture, and Operations.

3.1. Strategy

According to Professor David L. Rogers, "Digital transformation must be a synthesis of two elements: strategy and intrinsic transformation within the organization. To succeed in digital transformation, special attention must be given to these two factors." Digital transformation involves not only technology (Kane et al., 2015) but also requires a focus on staff-related factors, alongside changes in organizational strategy, structure, and processes (Hess et al., 2016).

Recent research suggests that the healthcare industry can apply operational management models developed in manufacturing to improve performance in the evolving healthcare environment (Heineke, 1995; Roth & Van Dierdonck, 1995; Butler et al., 1996).

Developing an appropriate operational strategy is key to enhancing the utilization and financial effectiveness of the hospital (Butler et al., 1996).

3.2. Customer experience

Digital transformation equips organizations with various capabilities to improve customer processes, effectively interact with customers, and enhance product features to better the customer experience (Piccinini, 2015; Sahu, 2018). Laus and Nguyen (2013) examine customer interaction processes to implement digital transformation aimed at improving customer experience. Berman (2012) analyzes key factors for reimagining customer value propositions to enhance customer experience during digital transformation.

Overall, the implementation of digital transformation solutions has increased automation and connectivity by improving patient care efficiency and administrative processes (Duong, 2015; Tortorella et al., 2022). Digital transformation has made life easier, safer, longer, and more efficient for patients and healthcare providers (Angst et al., 2010; Tian & Xu, 2015).

3.3. Information systems and technological infrastructure

A Hospital Information System (HIS) is an integrated system that enhances patient care by improving knowledge and reducing uncertainty for informed decisions (Vegoda, 1987). It includes software for data collection and supports hospital operations with appropriate technology (Garrido et al., 2004; Chen & Hsiao).

Overall, doctors are not concerned about technology replacing them and are skeptical about technology surpassing human capabilities in providing care. (Blease et al., 2018; Doraiswamy et al., 2018; Tasdogan, 2020). However, physicians believe that new technologies will change their profession (Sarwar et al., 2019; Tasdogan, 2020) and are optimistic about technology's potential as a diagnostic tool and in improving healthcare delivery, reducing administrative burdens (Blease et al., 2018). Some respondents suggest that record-keeping and updating medical records could be replaced by AI and machine-learning technologies (Doraiswamy et al., 2018).

Previous findings conclude that technological capability positively affects patient services and innovation in service processes (Kitsios & Kamariotou, 2020). New technology enables healthcare providers to develop high-tech services, personalize offerings, and adjust to patient needs. (Bukowski et al., 2020).

3.4. People and culture

An organization's culture connects people, work, workgroups, and their purpose (Coyle, 2018). Culture is a set of widely shared and strongly maintained norms and values throughout the organization (O'Reilly & Chatman, 1996).

Digital transformation contributes to creating a more integrated work culture, supporting collaborative efforts between different departments within the hospital to achieve the best health outcomes for patients (Sannino et al., 2018; Bergey et al., 2019). Based on studies by Chen et al. (2012), Kitsios and Kapetaneas (2022), Marsick and Watkins (2003), it is affirmed that culture can positively impact a hospital's digital transformation. The impact of technology on outcomes related to hospital staff and work has been identified as an important research direction (Venkatesh, 2006; Venkatesh & Bala, 2008).

If employees perceive that digital technology will be useful for their work and will help them perform their tasks, while being easy to learn and use, the likelihood of adoption increases (Burton-Jones & Hubona, 2006; Wang et al., 2014). Acceptance of change and flexibility are crucial factors in building a digital culture, helping employees adapt to changes in technology and workflows (Gartner, 2022).

3.5. Operations

Effective operations play a critical role in seamlessly integrating and utilizing digital technologies in healthcare facilities (Cormican et al., 2023; Kumar et al., 2023). Dr. Hayes asserts that digital technology helps manage resources more effectively and improves operational performance by using data analytics and advanced technology to optimize resources and processes. Digital tools in hospitals enhance the accuracy and reliability of operational processes,

from reducing errors to improving service quality.

Evaluating the hospital's operational level will provide accurate information on the progress of digital transformation, thus helping to identify appropriate improvement methods (Kohli & Grover, 2008; Thatcher & Pingry, 2007).

Based on the compiled factors, the authors propose a model for assessing the level of digital transformation in hospitals as follows:

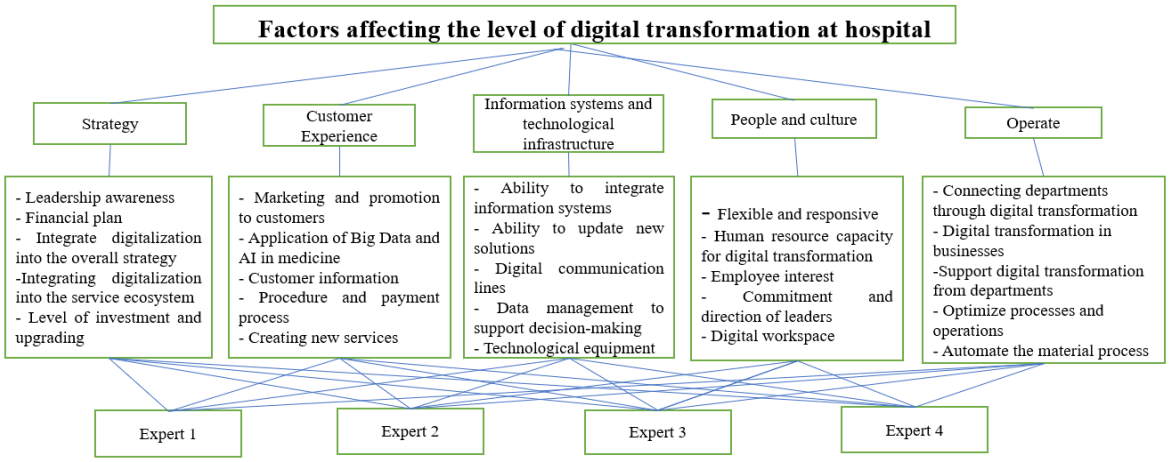

Figure 1: Model to evaluate the level of digital transformation in hospitals
Source: Authors.

4. Research methodology

4.1. Analytic Hierarchy Process (AHP)

In this study, data was collected through interviews with 06 experts in digital transformation and healthcare. After reviewing their responses, 04 experts were selected based on the relevance of their answers to each other and the literature review. These experts will then choose and assign weights to the criteria according to the following steps:

Step 1: Define the evaluation criteria

From the literature review combined with the practical situation of businesses, 04 experts discussed and selected 5 criteria for the evaluation process, including Strategy (C1), Customer Experience (C2), Information Systems and Technology Infrastructure (C3), People and Culture (C4), Operations (C5). At this step, the decision-making committee will assess the options based on the proposed criteria. The opinions of the decision-making committee are represented through specific linguistic variables as outlined in Table 1.

Table 1: Criteria for assessing the level of digital transformation of hospitals in Hanoi City

No.	Criteria code	Main criteria	Sub-criteria	Definition	References
1	C11	Strategy (C1)	Leadership awareness	Leaders' awareness of the benefits and trends of digital transformation in hospital operations.	Vial (2019), Berman (2012), Duong (2024), Martarazzo (2021)
2	C12		Financial planning	The hospital implements a financial plan to support digital transformation.	
3	C13		Integration of digitalization into overall strategy	The degree to which digital transformation solutions are integrated into the hospital's overall strategy.	
4	C14		Integration of digitalization into service ecosystem	Integration of digital solutions for a connected hospital ecosystem.	
5	C15		Level of investment and upgrade	The extent of investment in IT systems and data analytics to support strategic management.	

6	C21	Customer experience (C2)	Marketing and promotion to customers	The degree of applying digital solutions in marketing and promoting hospital services.	Vial (2019), USAID (2020
7	C22		Application of Big Data and AI in medicine	Extent of using big data and AI in disease forecasting, diagnosis, and treatment.	
8	C23		Customer information management	Application of digital solutions in managing patient information.	
9	C24		Procedures and payment processes	Degree of digital transformation in optimizing customer procedures and payments.	
10	C25		Creation of new services	Extent of digital transformation in creating services like telemedicine and home visits.	
11	C31	Information Systems and Technology Infrastructure (C3)	Integration capability of information systems	Capability and capacity for integrating information systems for enhancement.	Vial (2019), Duong (2024), USAID (2020)
12	C32		Ability to update new solutions	Capability to adopt new digital transformation solutions in the market.	
13	C33		Digital information transmission	Quality of the hospital's digital information transmission for medical operations.	
14	C34		Data management supporting decision making	Implementation of data policies to support decision-making.	
15	C35		Technology equipment	Degree of integration of technology into management and medical practices.	
16	C41	Human and culture (C4)	Flexibility and response	The hospital's level of flexibility in responding to changes in the healthcare sector.	Zhou (2021), Duong (2024), Georg (2020), Nguyen (2022)
17	C42		Personnel capacity for digital transformation	Staff have the knowledge, skills, and experience for digital transformation.	
18	C43		Employee engagement	The degree of employee interest in the hospital's digital transformation efforts.	
19	C44		Commitment and leadership direction	Extent of management's commitment to digital transformation in healthcare.	
20	C45		Digital workspace	The level of digital transformation applied to create a digital workspace.	
21	C51	Operation (C5)	Department connectivity through digital transformation	The application of digital transformation solutions to connect various departments within the hospital.	USAID (2020), Vial (2019)
22	C52		Digital transformation in operations	The integration of digital transformation in hospital management, finance, accounting, planning, legal, and HR operations.	
23	C53		Support for digital transformation from departments	The ability of finance, accounting, planning, and legal to support digital transformation.	
24	C54		Optimizing processes and operations	Application of digital transformation to optimize core operations.	
25	C55		Automation of supply processes	Automation in managing medical supplies improves with digital adoption.	

Source: Authors.

Step 2: Establishing the decision-making council:

The council consists of four decision-making experts: D1, D2, D3, D4.

Step 3: Determining the weights of the criteria

After identifying the criteria for assessing the level of digital transformation in hospitals, the council members are required to provide pairwise comparative evaluations of the criteria using Chang's AHP model (1996) to determine the weights of the criteria.

The results indicate that the weighted value of the main criterion C1 (w_1 = 0.376) is the highest, followed by the weighted value of the main criterion C3 (w_3 = 0.169), criterion C4 (w_4 = 0.168), criterion C2 (w_2 = 0.154), and finally, criterion C5 (w_5 = 0.134). This means that the factor "Strategy" has the greatest impact on the level of digital transformation in hospitals compared to the other factors. The factor "Information systems and technology infrastructure" has the second greatest impact, followed by the factors "People and Culture," "Customer experience," and lastly, the factor "Operations."

Step 4: Calculate the final value of the criteria corresponding to each standard

After determining the weights of the criteria corresponding to each standard, the members of the Council were requested to calculate the final values of the criteria corresponding to each standard using Chang's AHP model (1996) based on formula (3). The results are presented in Table 3.

4.2. Fuzzy comprehensive evaluation method (FCE)

The specific steps for processing fuzzy data using the FCE method include:

Step 1: Identify the set of criteria to be evaluated (Factor set)

The set of factors for each level is established according to a hierarchical structure model. In this study, the factor set is U = {strategy, customer experience, information systems and technology infrastructure, people and culture, operations}.

Step 2: Identify the evaluation set

The evaluation set V includes levels from Strongly Disagree (1) to Strongly Agree (5). Therefore, the set V is defined as V = {1, 2, 3, 4, 5}.

Step 3: Determine the weights (W) for the criteria

The weights W = {w1, w2, …, wm} are used to represent the relative importance of each criterion Uj. These weights must satisfy the condition: w1 + w2 +…+ wm = 1.

Step 4: Establish the evaluation matrix (R)

The evaluation matrix R is constructed based on the assessments for each criterion Each criterion can be evaluated using a fuzzy set of values, and the evaluation scale includes five levels: Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree, with corresponding values from 1 to 5.

$$R=\begin{pmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \cdots & \cdots & \cdots & \cdots \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{pmatrix}$$

where r_{ij} is the percentage of responses indicating that criterion Ui was rated at level j.

Step 5: Calculate the aggregated matrix (B)

The aggregated matrix B is calculated by multiplying the weight matrix W with the evaluation matrix R. The result of this multiplication is: B = W x R

where W is the row vector of the weights of the evaluation criteria, and R is the evaluation matrix.

Step 6: Calculate the aggregated value (C)

The aggregated value for each object U_i according to the criteria is calculated by summing the values in matrix B and multiplying them by the corresponding weights for each criterion:

$$C_i = \sum_{j=1}^{m} b_{ij} \times w_j$$

where b_{ij} is the evaluation value for criterion A_j, and w_j is the weight of criterion A_j.

In this study, data was collected through quantitative surveys distributed to leaders, employees, and customers in hospitals. The surveys aimed to gather opinions on the level of digital transformation, focusing on aspects such as strategy, customer experience, information systems, technology infrastructure, people and culture, and operations.

A total of 300 samples were randomly selected from different levels and positions in hospitals across Hanoi to ensure diverse perspectives on the digital transformation process.

Table 2: Division of digital maturity level

Maturity level	Score range	Explanation of maturity level
Beginner	(0,1]	Hospitals are aware of digital transformation but haven't prepared for it.
Starter	(1,2]	Hospitals are aware of digital transformation and have begun infrastructure development.
Practitioner	(2,3]	Hospitals have comprehensively implemented digital transformation and started sharing data within and across departments.
Practitioner	(2,3]	Hospitals have comprehensively implemented digital transformation and started sharing data within and across departments.
Leader	(4,5]	Hospitals have completed digital transformation, integrated data across the ecosystem, and greatly enhanced their ecosystem status.

Source: Authors.

5. Discussion results

5.1. Result on the importance level of digital transformation factors using the AHP method

The results in Table 3 show the final values of the criteria dependent on the main criteria (C1 to C5) from t_{11} to t_{53}. Specifically, for the main criterion C1 "Strategy", the final values of the sub-criteria increase sequentially from t_{14} = 0.039, t_{13} = 0.062, t_{15} = 0.067, t_{12} = 0.077, to t_{11} = 0.131. This indicates that sub-criterion C11 is the most important in determining the level of digital transformation in hospitals, followed by sub-criteria C12, C15, C13, and C14.

For the main criterion C2 "Customer Experience", the final values of the sub-criteria increase from t_{22} = 0.020, t_{21} = 0.021, t_{24} = 0.036, t_{23} = 0.038 (0.0377), to t_{25} = 0.038. This indicates that sub-criterion C25 is the most important, followed by C23, C24, C21, and C22.

For the main criterion C3 "Information systems and technology infrastructure," the final values of the sub-criteria increase respectively from t_{32} = 0.019, t_{34} = 0.033, t_{33} = 0.034, t_{35} = 0.040, to t_{31} = 0.043. This indicates that sub-criterion C31 is the most important, followed by sub-criteria C35, C33, C34, and C32.

For the main criterion C4 "People and Culture," the final values of the sub-criteria increase respectively from t_{41} = 0.016, t_{43} = 0.025, t_{45} = 0.034, t_{44} = 0.038, to t_{42} = 0.055. This indicates that sub-criterion C42 is the most important, followed by sub-criteria C44, C45, C43, and C41.

For the primary criterion C5 "Operation," the final values of the subordinate criteria sequentially increase from t_{55} = 0.018, t_{51} = 0.019, t_{53} = 0.023, t_{52} = 0.029, to t_{54} = 0.044. This indicates that sub-criterion C54 is the most important, followed by sub-criteria C52, C53, C51, and C55.

Table 3: Weight values of sub-criteria dependent on the main criterion

	Standard number average (w_j = 1;5)		**Average weight of criteria** (w_{jg} = 11;53)	**Final value** (t_{jg} = 11;53)
C1	0.376	C11	0.349	0.131
	0.376	C12	0.205	0.077
	0.376	C13	0.165	0.062
	0.376	C14	0.103	0.039
	0.376	C15	0.178	0.067
C2	0.154	C21	0.138	0.021
	0.154	C22	0.130	0.020
	0.154	C23	0.246	0.038
	0.154	C24	0.237	0.036
	0.154	C25	0.250	0.038
C3	0.169	C31	0.253	0.043
	0.169	C32	0.114	0.019
	0.169	C33	0.201	0.034
	0.169	C34	0.194	0.033
	0.169	C35	0.239	0.040
C4	0.168	C41	0.094	0.016
	0.168	C42	0.326	0.055
	0.168	C43	0.150	0.025
	0.168	C44	0.227	0.038
	0.168	C45	0.203	0.034
C5	0.134	C51	0.144	0.019
	0.134	C52	0.214	0.029
	0.134	C53	0.176	0.023
	0.134	C54	0.330	0.044
	0.134	C55	0.136	0.018

Source: Authors.

The findings show that "Leadership Awareness" (C11) under "Strategy" (C1) has the greatest impact (t_{11} = 0.131), while "Flexibility and Feedback" (C41) under "People and

Culture" (C4) has the least impact (t_{41} = 0.016) on hospital digital transformation.

5.2. Result on the level of digital transformation using the FCE method.

After sorting and processing the data from the valid questionnaires, the fuzzy comprehensive evaluation vector for the criteria C1, C2, C3, C4, and C5 is presented below:

The fuzzy comprehensive evaluation matrix for the criteria C1, C2, C3, C4, and C5 is:

$$\begin{matrix} \backslash 0{,}01 & 0{,}06 & 0{,}28 & 0{,}46 & 0{,}19/ \\ \backslash 0{,}00 & 0{,}02 & 0{,}18 & 0{,}46 & 0{,}34/ \\ \backslash 0{,}00 & 0{,}04 & 0{,}32 & 0{,}44 & 0{,}19/ \\ \backslash 0{,}01 & 0{,}02 & 0{,}27 & 0{,}46 & 0{,}23/ \\ \backslash 0{,}00 & 0{,}06 & 0{,}30 & 0{,}45 & 0{,}19/ \end{matrix}$$

The weight vectors for the criteria C1, C2, C3, C4, and C5 are analyzed and calculated using the AHP method as follows:

$$w_1 = (0{,}349 \quad 0{,}205 \quad 0{,}165 \quad 0{,}103 \quad 0{,}178)$$
$$w_2 = (0{,}138 \quad 0{,}130 \quad 0{,}246 \quad 0{,}237 \quad 0{,}250)$$
$$w_3 = (0{,}253 \quad 0{,}114 \quad 0{,}201 \quad 0{,}194 \quad 0{,}269)$$
$$w_4 = (0{,}094 \quad 0{,}326 \quad 0{,}150 \quad 0{,}227 \quad 0{,}203)$$
$$w_5 = (0{,}144 \quad 0{,}214 \quad 0{,}176 \quad 0{,}330 \quad 0{,}136)$$

The aggregated weight vector for the criteria C1, C2, C3, C4, and C5 is calculated and analyzed as follows:

$$w_M = (0{,}376 \quad 0{,}154 \quad 0{,}169 \quad 0{,}168 \quad 0{,}134)$$

Calculating the results of the comprehensive fuzzy evaluation, we have the results of the comprehensive fuzzy evaluation for the criteria C1, C2, C3, C4, and C5 are as follows:

$$B_1 = R_1 \times w_1 = (0{,}0058 \quad 0{,}0577 \quad 0{,}2858 \quad 0{,}4219 \quad 0{,}1887)$$
$$B_2 = R_2 \times w_2 = (0{,}0055 \quad 0{,}0530 \quad 0{,}2034 \quad 0{,}4681 \quad 0{,}2700)$$
$$B_3 = R_3 \times w_3 = (0{,}0014 \quad 0{,}0488 \quad 0{,}3125 \quad 0{,}4547 \quad 0{,}1826)$$
$$B_4 = R_4 \times w_4 = (0{,}0051 \quad 0{,}0444 \quad 0{,}2512 \quad 0{,}4971 \quad 0{,}2023)$$
$$B_5 = R_5 \times w_5 = (0{,}0028 \quad 0{,}0552 \quad 0{,}2468 \quad 0{,}4838 \quad 0{,}2115)$$

The results of the comprehensive fuzzy evaluation for the level of digital transformation are:

$B_M = R_M$ x W_M = (0.0045 0.0529 0.2666 0.4075 0.2055)

Applying the centroid method to determine the level of digital transformation for each criterion, we obtained the following results: the digital transformation levels for criteria C1, C2, C3, C4, and C5 are 3.77, 3.94, 3.77, 3.85, and 3.85, respectively, with an overall digital transformation level of 3.82. The results show that the digital transformation levels for all criteria are at level 3, meaning they are all classified as "Practitioner".

6. Conclusion

This study evaluates the level of digital transformation in hospitals, highlighting its importance for healthcare, Vietnam's economy, and global integration. It also guides effective implementation to enhance service quality and public health.

The research results clearly indicate five main factors that strongly influence the implementation of digital transformation in hospitals within Hanoi. The first is the "Strategy" factor, followed by "Customer experience," "Information systems and technological infrastructure," "People and culture," and "Operations".

The evaluation of the digital transformation level at hospitals in Hanoi shows quite positive results but also highlights many challenges. Based on the Centroid method, the average digital transformation level across the evaluation criteria is 3.82, classified as "Practitioner," indicating that hospitals have applied digital technology in management and treatment, although not evenly. To enhance the quality of healthcare services, hospitals need to focus on building technological infrastructure, training personnel, and developing a comprehensive digital transformation strategy.

Furthermore, the research indicates that hospitals in Hanoi need to implement a number of solutions to improve digital transformation. First, they should develop a comprehensive digital transformation strategy with clear objectives and a specific roadmap, while regularly updating and measuring progress.

Second, it is essential to invest in IT infrastructure, upgrade data storage, processing systems, and networks, and apply cloud computing and artificial intelligence to improve efficiency.

Third, it is crucial to enhance the quality of healthcare human resource training, develop training programs, and encourage a culture of innovation to foster employee participation.

Fourth, improving customer experience through mobile applications and online appointment systems.

Finally, optimizing operational processes by automating and applying AI, will enhance performance and service quality.

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