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Digital Transformation Readiness of Hospital Information Management Systems: The Role of Technology and IT Personnel Strategies at Teaching Hospital

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Abstract: The digital transformation of Hospital Information Systems (HIS) has become an urgent necessity, particularly for teaching hospitals that fulfill the triple mission of healthcare service, education, and research. The gap between technological planning and Information Technology Human Resource (IT HR) readiness is a primary barrier to implementation, even when future business process flows are carefully designed. This study intends to develop an integrated HIS digital transformation roadmap aligned with technological and IT HR strategies for the 2026–2029 period. A qualitative case study approach was used, focusing on the IT division of a teaching hospital in Indonesia. Data were collected through a documentation study of the Hospital's 2025–2029 Strategic Plan, in-depth interviews with five key informants representing IT division, and observations. Data analysis followed a strategic cascading framework, integrating the Ward and Peppard, the Balanced Scorecard, and Bernard Marr's Future Skills framework. The findings identify eight primary technology strategy clusters and eight IT HR competency domains encompassing technical, human, and business skills. The Balanced Scorecard analysis produced sixteen measurable strategic objectives. The resulting integrated roadmap is divided into four phases, operating on the principle that IT HR competency development must precede the implementation of new technologies. This research delivers a traceable, strategic cascading model from the hospital's Strategic Plan to the implementation roadmap, which is replicable for other teaching hospitals in Indonesia facing the challenges of HIS digital transformation.

Keyword: Digital Transformation, Hospital Information System, Teaching Hospital, IS/IT Strategy, Roadmap.

INTRODUCTION

The healthcare sector is a strategic pillar of national development, as health system investments directly improve productivity, reduce disease prevalence, and encourage economic security (WHO, 2021). Such investments not only increase household income but also spur economic growth and job creation (WHO, 2021; World Bank, 2025). Consequently, digital transformation has been established as a global approach to strengthen medical care systems (WHO, 2021). The World Health Organization (WHO), through its Global Strategy on Digital Health 2020–2025, advocates for digital transformation as an integral component of national health priorities to achieve Universal Health Coverage (UHC) (WHO, 2021).

At the European Union level, digital health has been established as a primary strategic priority under the European Strategic Plan 2019–2024, showing a rapid worldwide shift toward digitalization (Stoumpos et al., 2023). Digital transformation in healthcare has progressed beyond only IT adoption into a multidisciplinary phenomenon that requires a fundamental redefinition of strategies, business processes, and organizational values (Vial, 2021). These conditions are further intensified by global pressures compelling medical systems to address rising service demands amidst constrained human resources and tightening budgets (Schiffelers et al., 2025). In this context, Information and Communication Technology (ICT) functions as a crucial driver, changing medical service delivery by boosting patient access, improving clinical outcomes, and increasing overall system efficiency (Hameed et al., 2024). The success of this change depends heavily on the organization's overall digital maturity, which encompasses governance, infrastructure, and social impact (Di Vaio et al., 2025).

Systematic reviews of digital maturity models in healthcare indicate that organizations must undergo progressive stages, ranging from basic system integration to the optimization of infrastructure powered by real-time analytics and Artificial Intelligence (AI) (Abdekhoda et al., 2025). However, achieving higher maturity levels is not determined solely by technology-related investments and leadership competencies, but also by organizational knowledge management and user readiness for change (Sirirak et al., 2025). Cross-national studies show that change management challenges are universal, regardless of the system's historical background, with the primary barrier being the lack of a comprehensive systemic approach to managing the digital transition (Vochozka et al., 2021).

In 2024, the Indonesian government launched its digital health transformation strategy, signified by the development of an integrated data system through the Indonesia Health Service (IHS) platform, known as SATUSEHAT. This program intends to integrate health data across all facilities, including hospitals (Kementerian Kesehatan RI, 2021). This mandate directly influences the case study in this research: a teaching hospital in Indonesia. Teaching hospitals possess unique organizational characteristics that simultaneously balance patient care, education, and research. Digital transformation in this academic context requires strategic planning that involves cross-functional stakeholders (Hügler & Grek, 2023). Although HIS development plans are often technically mapped via timelines, significant challenges arise during implementation. These barriers frequently stem from organizational digital unreadiness, including managerial resistance and technical limitations among users (Al-Azzam et al., 2025). Moreover, the success of healthcare digital transformation depends on HR's managerial and technical capacity, specifically in digital competence, change leadership, and data-driven decision-making (Brommeyer & Liang, 2022).

The core issue is a strategic gap between the technological objectives outlined in technical plans and the reality of HR and supporting infrastructure, where a phenomenon of "business processes following technology" often occurs. Research by Kamel Rahimi et al. (2024) explains that transitioning from dataset-based system development to real-time data integration into clinical workflows is a highly complex challenge. Success is determined by integrated enablers across human, process, information, and technology dimensions (Kamel

Rahimi et al., 2024). Furthermore, significant investments in AI and digital innovations, including IoT, telemedicine, and clinical decision support systems, require a strategic framework to align technological capabilities, operational readiness, and clinical value (Kamel Rahimi et al., 2024). Primary obstacles include ambiguity during implementation, inconsistent training, resource constraints, and weak infrastructure supporting innovation (Lim et al., 2025). Such unreadiness can lead to failure to meet international standards such as JCI, HIMSS, STARKES, or PSAK, even if "to-be" business processes have been well-designed (Al-Azzam et al., 2025; Brommeyer & Liang, 2022).

Organizations must integrate digital experiences across the entire patient journey to achieve sustainable transformation (Canfell et al., 2024). A study of Dutch hospitals emphasized that effective digital transformation requires the seamless integration of health technology into existing workflows; yet, a definitive, universally applicable strategy remains elusive (Schiffelers et al., 2025). This transition also demands a service design approach focused on user needs to prevent technology from becoming an operational bottleneck (Zhang et al., 2025). Research in developing countries further highlights that sustainable digital transformation in public hospitals is strongly influenced by strategic leadership, institutional knowledge repositories, and user-centric digital policies (Sirirak et al., 2025).

Effective digital transformation must be viewed as a holistic effort encompassing the restructuring of business strategies, operational efficiency, customer experience, and most fundamentally the strengthening of organizational capabilities (Vial, 2021; Lim et al., 2025). While research on IS/IT strategic planning in healthcare settings has applied frameworks such as Ward and Peppard and the Balanced Scorecard (Moinzad & Akbarzadeh, 2022), most studies focus primarily on technological aspects and do not comprehensively integrate IT HR development strategies.

Based on the identified research gap, this study formulates the following problem: "What are the technological and IT HR strategies required to support the HIS digital transformation readiness at the Teaching Hospital?" The objective of this research is to develop an integrated HIS digital transformation roadmap that aligns technological and IT HR strategies for the 2026–2029 period. This study employs a combination of the Ward and Peppard IS/IT strategic planning framework, the Balanced Scorecard as an IT strategic planning instrument, and Bernard Marr's Future Skills framework for IT HR competency mapping. The integration of these three frameworks produces a digital transformation roadmap covering technology, HR strategy, and IT governance, tailored for a teaching hospital within the 2025–2029 strategic planning cycle.

METHOD

This research uses a qualitative case study design at a teaching hospital in Indonesia. The qualitative approach was selected to formulate an integrated digital transformation strategic roadmap that corresponds to the technical development plans of the HIS and addresses issues that are inherently contextual, complex, and multidimensional (Creswell & Creswell, 2018). A case study design is appropriate when a study intends to understand a contemporary phenomenon in its real-life context, particularly when the boundaries between the phenomenon and its context are not clearly defined (Yin, 2018). Qualitative methods have been extensively employed in digital transformation research within the healthcare sector, including studies on the implementation of HIS and the development of digital strategies in academic hospitals (Wieslander et al., 2024). The three frameworks are integrated in a deliberate cascade architecture. Ward and Peppard translate hospital business strategy into IS/IT requirements; the Balanced Scorecard converts these as measurable objectives across four perspectives; and Bernard Marr's Future Skills Framework maps the Tech Skills, Human Skills and Business Skills required to execute the roadmap and address dimensions that neither of the preceding frameworks explicitly covers. Following the qualitative assessment,

the research methodology was further structured into specific roadmap development stages, as delineated in Figure 1.

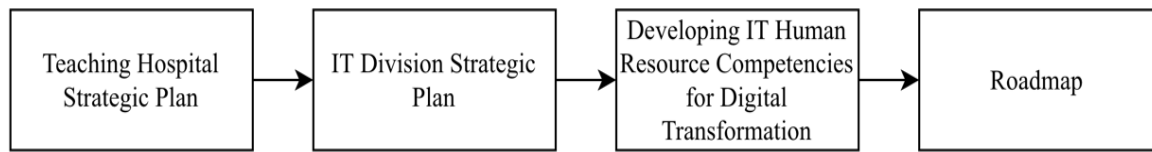


Figure 1. Roadmap Development Stages

The roadmap development process begins by reviewing the teaching hospital's strategic plan, which is drawn from the 2025 to 2029 strategic plan. The teaching hospital's strategic plan has core standards focusing on patients, education, and research. The teaching hospital's strategic plan is then examined using the Ward and Peppard framework, employing three tables: the Strategy-to-Innovation table, the IS Strategy table, and the IT Strategy table. The results of these three tables serve as the foundation for designing the IT Division strategic plan, which is mapped using the IT Balanced Scorecard. The resulting IT strategic plan is then used as a basis for reviewing IT human resource competencies. The analysis of these three frameworks is subsequently used to map the implementation of the HIS digital transformation in both technology and IT human resources for the 2026 to 2029 period.

RESULTS AND DISCUSSION

This section describes the approach used to develop the roadmap, starting with the identification of the teaching hospital's strategic objectives and proceeding to the formulation of the HIS Digital Transformation Technology and IT Human Resources roadmap for 2026 to 2029. Furthermore, it provides an evaluation of the resulting roadmap generated in this study. The first stage of this research is to examine the strategic plan of a selected teaching hospital for the period 2025–2029 as the starting point for the strategic cascading process. According to Peppard and Ward (2016), an effective IS/IT strategy must be derived from and consistent with the organization's business strategy, not vice versa. Therefore, the hospital's strategic plan serves as the authoritative, non-negotiable source in formulating all subsequent IT strategies (Peppard & Ward, 2016). Based on the analysis of the teaching hospital's strategic plan document, four main strategic objectives were identified that are directly related to the needs of information systems and technology. These are presented in Table 1.

Table 1. Relevance to IS/IT with Strategic Plan Analysis

No	Strategic Objectives of the Strategic Plan	Relevance to IS/IT
1.	Achieving customer and stakeholder satisfaction	Requires end-to-end digitalization of the patient journey, mobile apps, and an integrated personnel system
2.	Realizing good corporate governance and cultural transformation	Requires standardized IT governance, a new Hospital Management Information System (HIS) with audit trail, and integration with the campus system
3.	Creating innovation with tangible impact	Requires a digital innovation platform and enhanced IT human resource capacity for innovation execution
4.	Realizing sound and independent financial performance	Requires BPJS claim automation, insurance integration, and a host-to-host bank payment gateway

The analysis in Table 1 confirms that the four strategic objectives are fundamentally dependent on IS/IT as their primary enabler, making each objective a valid and traceable input for the subsequent development of the IS/IT strategy. These four strategic objectives serve as the foundation for the analysis in the following phase. It is important to note that not all objectives from the strategic plan need to be included in the IS/IT analysis—only those

that can be addressed in a significant way through the selected information technology interventions. This approach helps prevent overscoping, which could otherwise weaken IS/IT's tactical focus. In addition to strategic objectives, the analysis of the teaching hospital's strategic plan can also be used to identify IT Division Performance Indicators as sources of Critical Success Factors. The Ward and Peppard framework is implemented through three analyses: the strategy-to-innovation analysis, the IS strategy table, and the IT strategy table. Each analysis is organized to establish a traceability path in which the output of each table serves as the input to the next.

Strategy to Innovation

The strategy to innovation is a stage that bridges the business strategy of the teaching hospital with the need for information system innovation. This strategy identifies the gaps between the business processes within the teaching hospital and the current processes in operation, subsequently generating the necessary innovations. The gap analysis findings for each strategy are as follows:

- a) Achieving customer and stakeholder satisfaction: Five gaps were identified:
 - i. The HIS has not yet implemented all patient journey modules end-to-end.
 - ii. The features within the mobile apps do not yet cover all services offered by the teaching hospital.
 - iii. The employee performance and career systems remain siloed.
 - iv. Limited IT human resource capacity, resulting in slower system development.
 - v. Rapid policy changes from the Ministry of Health and BPJS outpace the system adaptation within the teaching hospital.

These five gaps result in five innovations: phased development of HIS modules based on the patient journey, further development of mobile apps, implementation of digital work management systems, strengthening of IT human resource capacity, and the establishment of a fast-track regulatory adaptation team.

- b) Realizing good corporate governance and cultural transformation: Identified gaps include incomplete IT governance documentation, a recurring audit finding, and the current HIS not meeting modern governance standards. The recommended innovations are migrating to a new, independently developed HIS with audit-trail features, implementing RBAC, and separating super-user access rights from system providers.
- c) Creating innovation with tangible impact: Identified gaps include the inability to realize all innovation programs due to the increasing number of innovation initiatives across units, while IT execution capacity remains limited, and the absence of a formal mechanism for identifying, selecting, and developing innovations. Recommended innovations include establishing an IT digital innovation forum, an internal innovation incubation program, and a planned roadmap for participation in innovation competitions.
- d) Realizing sound and independent financial performance: Identified gaps include that the hospital does not yet have a host-to-host connection with banks, HIS is not yet integrated with private insurance systems, so claims are still processed manually, and HIS has become a bottleneck in speeding up BPJS claim processing. The recommended innovations consist of implementing a host-to-host payment gateway, integrating HIS with private insurance via API, and upgrading the BPJS claim module for full automation.

The identified gaps and innovations for each strategic objective are then used as the basis for translating these innovations into the IS strategy.

IS Strategy (Business Process to Application & Data)

The IS strategy stage translates the gaps and innovations identified in the strategy to the innovation phase. The IS strategy results in eight clusters of Business Process Innovation (BPI), along with the required data and applications, as well as the standards and regulations

that serve as the basis for justifying the application requirements. The BPI clusters, along with the application requirements and key policy and standard foundations, are presented in Table 2. To preserve readability in the main text, Table 2 presents a condensed version of the full IS Strategy output, highlighting only the BPI cluster, the primary required applications, and key standards and regulations as the most critical dimensions to understand each cluster's strategic direction.

Table 2. 8 Cluster BPI Table

BPI Cluster	Required Applications (Primary)	Key Standards and Regulation
Customer Satisfaction: Patient Journey	Comprehensive EMR module, online registration, digital queue, integrated pharmacy & laboratory	PERMENKES 24/2022, Starkes 2024 MRMK, JCI IM, HIMSS EMRAM L6-7
Customer Satisfaction: Mobile & Payment	Android/iOS mobile application, payment gateway, digital medical record portal	UU PDP 2022, JCI PFR, HIMSS EMRAM L6
Employee Satisfaction: Performance System	Digital performance assessment module, career & training module, HR system integration	Starkes 2024 KKS, JCI SQE
IT Governance: New HIS	Independently developed HIS, automated audit trail, RBAC, monitoring dashboard	Starkes 2024 MRMK, JCI IM.2, HIMSS EMRAM L7
IT Governance : Risk and Document	IT document management system, digital risk register, IT KPI dashboard	Starkes 2024 PMKP, JCI QPS, HIMSS EMRAM L5-6
IT Governance : Environmental Monitoring	IoT monitoring system, integrated sanitation & IT dashboard	Starkes 2024 MFK, JCI FMS
Digital Innovation	Idea & innovation management platform, prototype documentation portal	JCI GLD, internal intellectual property rights policy
Finance : Claim and Payment	Bank payment gateway, private insurance bridging, BPJS claims automation	BPJS Regulations, BI, PSAK 45/72, Starkes ARK

The four accreditation standards targeted by the hospital are Starkes 2024, JCI 8th Edition, HIMSS EMRAM, and PSAK, each assigned to the most relevant cluster. This approach results in a more accurate and accountable mapping of compliance requirements for accreditation auditors. Specifically, for the payment and claims cluster, it was found that uniting PSAK 45 and PSAK 72 is a requirement often overlooked in hospital IS/IT planning. PSAK 45 governs revenue recognition for non-profit entities, while PSAK 72 regulates revenue recognition from contracts with customers. Both have a direct impact on the design of the billing and claims modules within HIS and must therefore be integrated from the application planning stage.

IT Strategy (Application & Data to Infrastructure)

The IT strategy is the final stage in the Ward and Peppard framework sequence, where application requirements from are translated into infrastructure requirements. The six infrastructures cluster identified in table 3.

Table 3. Infrastructure Cluster Table

Infrastructure Cluster	Required Infrastructure (Primary)	Key Governance
HIS & Patient Journey	High-availability application server, database failover, WiFi coverage, bandwidth ≥100 Mbps, UPS & generator	<ul style="list-style-type: none"> • PERMENKES No. 24/2022 (RME & clinical information systems) • ITIL v4 (IT Service Management Framework) • ISO 9001:2015 (service quality & availability management) • Hospital IT Governance Policy (Business Continuity & Availability)
Mobile Apps & Payment	CDN, SSL/TLS, push notification server, PCI-DSS payment gateway, MDM	<ul style="list-style-type: none"> • UU PDP No. 27/2022 (personal data protection governance) • PCI-DSS v4.0 (payment card industry security standard) • OWASP Mobile Application Security Standard • Hospital IT Security Policy (data confidentiality & access control)
New HIS & Audit Trail	Dedicated server for new HIS, log server & SIEM, IAM, tier-1 encrypted storage, separated environments (dev/staging/prod)	<ul style="list-style-type: none"> • ISO 27001:2022 (Information Security Management System (ISMS)) • PERMENKES No. 24/2022 (audit trail & integrity of medical records) • Hospital RBAC & Access Control Policy • Hospital Data Retention & Classification Policy
IT Governance & Risk	Intranet server for document management, governance document backup storage	<ul style="list-style-type: none"> • ISO 9001:2015 (document control & quality management) • ISO 27001:2022 (information asset management) • ITIL v4 (change & configuration management framework) • Hospital IT Document Management Policy
IoT Environmental Monitoring	IoT gateway & sensors, dedicated IoT VLAN separated from clinical network	<ul style="list-style-type: none"> • NIST IoT Cybersecurity Framework • ISO 27001:2022 (network security & asset management) • PERMENKES MFK (environmental facility & safety standards) • Hospital Network Segmentation & IoT Security Policy
Payment & Claim	API management platform, dedicated leased line to BPJS, end-to-end encryption, financial transaction log server, BPJS failover connection	<ul style="list-style-type: none"> • BPJS Kesehatan Regulations (claims & bridging governance) • Bank Indonesia Regulations (digital payment governance) • PCI-DSS v4.0 (financial transaction security standard) • UU PDP No. 27/2022 (financial data protection) • Hospital API Security & Financial Data Transmission Policy

The findings in the IT strategy table indicate the need to separate the infrastructure of the old and new HIS during the migration transition period. A dedicated server for the new HIS, separated from the existing HIS, is a non-negotiable technical requirement to ensure zero data loss and service continuity during migration. This requirement aligns with the

documented migration challenges in the literature on EHR-to-EHR transitions. Miake-Lye et al. (2023), in a systematic review of EHR transition studies, found that parallel system operation is a commonly adopted strategy to prevent service disruption, as simultaneous cutover poses unacceptable clinical risk in high-volume healthcare environments, and that infrastructure separation is a prerequisite for sustaining data quality and governance compliance throughout the world. system. transition period. Infrastructure separation is further justified in the context of this study by the simultaneous pursuit of HIMSS EMRAM Level 7 and ISO 27001 certification, both of which require demonstrable data validity and system availability throughout the transition period. The separation of development, staging, and production environments — as specified in the IT strategy table — is therefore not merely a technical preference but a governance-mandated architecture that ensures the hospital meets its accreditation obligations without interruption to clinical operations. In addition, the implementation of SIEM within the new HIS cluster has significantly increased security requirements, in line with the growing complexity of the hospital's digital infrastructure.

IT Division Strategic Plan

The IT Division Strategic Plan is developed using the Balanced Scorecard (BSC) approach, adapted for the context of the IS/IT Strategic Plan (Moinzad & Akbarzadeh, 2022). The BSC accommodates different perspectives from stakeholders to human resource capacity within a single, coherent and measurable strategic framework. Research by Hügler & Grek (2023) demonstrated that the BSC can align the interests of heterogeneous stakeholders into an actionable digital strategy. The IS/IT Strategic Plan for the IT division comprises 16 strategic objectives across four BSC perspectives Stakeholder, Internal Process, Financial, and Learning & Growth to distributed across all three IT divisions. The highest targets (HIMSS EMRAM Level 7, JCI 8th Edition, ISO 27001) are set for 2029, showing a realistic, gradual approach consistent with the capacity of the organization. The interrelation of these four perspectives forms a logical causal chain that can be empirically tested during the evaluation phase of the roadmap. The table is presented in table 4.

Table 4. IT Division.Strategy Plan

Perspective	Strategic Objectives	Key Performance Indicator (KPI)	Target 2029
STAKEHOLDER (Customer & Accreditation)	Improving patient satisfaction through end-to-end service digitalization	Patient satisfaction score for digital services	≥ 85%
	Improving employee satisfaction through integrated digital systems	Employee satisfaction score for IT systems	≥ 80%
	Supporting the achievement of all national and international hospital accreditation standards (Starkes, JCI, HIMSS, ISO)	Number of accreditation standards fulfilled from an IT perspective	4 standards fulfilled
	Supporting the educational and research functions of the Teaching Hospital through IS/IT	Student & researcher satisfaction with HIS	≥ 80%
FINANCIAL (Finance & Efficiency)	Supporting the acceleration of BPJS and insurance claims processing through system automation	Percentage of claims processed automatically without technical rejection	≥ 95%
	Supporting the implementation of host-to-host payment gateway with banks	Percentage of patient digital payment transactions	≥ 70%
	Improving IT operational efficiency through budget and resource optimization	Ratio of IT budget realization to target deliverables	≥ 90%

Perspective	Strategic Objectives	Key Performance Indicator (KPI)	Target 2029
INTERNAL PROCESS (IT Operations)	Realizing an integrated HIS supporting all clinical and non-clinical business processes	Percentage of HIS modules fully integrated (frontend, backend, external)	100%
	Realizing reliable, secure, and standards-compliant IT infrastructure	System uptime	≥ 99.5%
	Realizing network and data security compliant with national and international standards	Number of cybersecurity incidents successfully prevented / resolved	100% resolved
	Realizing standardized and auditable IT governance	<ul style="list-style-type: none"> Percentage of IT audit findings followed up Percentage of IT KPIs achieved 	≥ 80%
	Driving digital innovation with tangible impact on the hospital	Number of digital innovations realized per year	≥ 3 innovations/year
LEARNING & GROWTH (HR & Capacity)	Developing technical competencies of IT HR in line with digital transformation needs	Percentage of IT HR with competencies aligned to roadmap requirements	≥ 90%
	Developing IT organizational capacity to support delivery of more than 5 applications per year	Number of applications successfully delivered per roadmap	≥ 5 applications
	Aligning IT organizational structure with digital transformation requirements	Availability of an IT organizational structure supporting all strategic initiatives	New structure effective 2026
	Building a culture of innovation and continuous learning within the IT unit	Percentage of IT HR participating in training/development per year	100%

Mapping of IT Human Resource Competencies: Bernard Marr’s Future Skills Framework

The Future Skills framework developed by Bernard Marr (2022) is used. This system was chosen because it classifies competencies into three complementary categories: Tech Skills, Human Skills, and Business Skills, thereby surpassing established approaches that focus solely on technical competencies (Marr, 2022). The main input for this table is the “IS/IT Strategy” column, derived from the IS/IT Strategic Plan, particularly the Internal Processes and Learning & Growth perspectives. Each IS/IT strategy is evaluated to identify CSFs from a human resource perspective, which are then mapped to the specific competencies required, along with the development methods for each. The table is presented in table 5.

Table 5. Bernard Marr’s Future Skills Framework

IS/IT Strategy	Critical Success Factor	Competency (Bernard Marr)	Development Method
Integrated HIS Development for Patient Journey	<ul style="list-style-type: none"> HIS stability ≥ 99.5% uptime All patient journey modules 100% integrated Clinical user adoption ≥ 80% 	<p>Tech Skills:</p> <ul style="list-style-type: none"> Digital platform proficiency: HIS configuration & troubleshooting Software development: independent module development Data literacy: clinical data flow across modules <p>Human Skills:</p> <ul style="list-style-type: none"> Adaptability: flexibility in response 	<ul style="list-style-type: none"> HIS technical training Vendor certification On-the-job training Module integration workshop Programming upskilling

IS/IT Strategy	Critical Success Factor	Competency (Bernard Marr)	Development Method
		to system & regulatory changes <ul style="list-style-type: none"> • Collaboration: cross-divisional (IT, clinical, management) 	
New HIS Migration & Audit Trail	<ul style="list-style-type: none"> • New HIS go-live on schedule • Audit trail & RBAC fully operational • Zero data loss during migration 	Tech Skills: <ul style="list-style-type: none"> • Software engineering: system architecture, clean code, testing • Database management: data migration, query optimization • Cybersecurity: RBAC & encryption implementation Business Skills: <ul style="list-style-type: none"> • Project management: Agile/Scrum for large-scale projects • Risk management: system migration risk mitigation 	<ul style="list-style-type: none"> • Agile/Scrum training • Software architecture workshop • Database migration training • CompTIA Sec+ certification • HIS benchmarking at other hospitals
Mobile Apps & Payment Gateway	<ul style="list-style-type: none"> • Apps available on Android & iOS, crash rate < 1% • Digital transactions running securely & in real-time • Digital transactions ≥ 70% 	Tech Skills: <ul style="list-style-type: none"> • Mobile development: Flutter/React Native • Cybersecurity: OWASP Mobile, PCI-DSS • API integration: payment gateway & push notification Business Skills: <ul style="list-style-type: none"> • Digital strategy: aligning app features with patient needs • UX thinking intuitive interface for patients 	<ul style="list-style-type: none"> • Mobile development bootcamp • OWASP Mobile training • UX/UI design workshop • Flutter/React Native upskilling • PCI-DSS compliance training
BPJS & Insurance Integration	<ul style="list-style-type: none"> • Automated claims without technical rejection ≥ 95% • Policy adaptation within < 30 days • Accurate data without duplicate entry 	Tech Skills: <ul style="list-style-type: none"> • API integration & web services: REST API, HL7 FHIR, SOAP • Data literacy: claims data validation & reconciliation Business Skills: <ul style="list-style-type: none"> • Regulatory literacy: BPJS, PSAK regulations • Critical thinking: problem-solving for data rejection/mismatch • Data-driven decision making for claims rejection pattern analysis 	<ul style="list-style-type: none"> • BPJS technical guidance • API integration workshop • HL7 FHIR training • Data validation upskilling • PSAK regulatory training
IT Infrastructure	<ul style="list-style-type: none"> • Uptime ≥ 99.5% • RTO < 4 hours 	Tech Skills: <ul style="list-style-type: none"> • Cloud & infrastructure: virtualization, server storage • Digital platform proficiency: monitoring & performance tuning Human Skills: <ul style="list-style-type: none"> • Critical thinking: root cause analysis for infrastructure disruptions • Adaptability: rapid response to system failures Business Skills: <ul style="list-style-type: none"> • Risk management 	<ul style="list-style-type: none"> • ITIL v4 training • VMware/cloud certification • Server management upskilling
Network & Data Security	<ul style="list-style-type: none"> • Zero critical data breaches • 100% security incidents resolved • Compliance with JCI & ISO 27001 	Tech Skills: <ul style="list-style-type: none"> • Cybersecurity: firewall, IDS/IPS, SIEM, encryption, zero-trust • IoT security: VLAN segmentation & IoT device security • Digital platform proficiency: 	<ul style="list-style-type: none"> • CompTIA Security+ certification • CISSP/CEH certification • ISO 27001 training • Penetration testing simulation

IS/IT Strategy	Critical Success Factor	Competency (Bernard Marr)	Development Method
	standards	network monitoring & management Human Skills: <ul style="list-style-type: none"> Critical thinking: threat analysis & incident forensics Business Skills: <ul style="list-style-type: none"> Regulatory literacy: ISO 27001, NIST, JCI & Starkes standards 	<ul style="list-style-type: none"> IoT security workshop
IT Governance & Risk Management	<ul style="list-style-type: none"> Complete & audited IT governance documentation Audit findings followed up $\geq 80\%$ IT KPIs achieved 100% 	Business Skills: <ul style="list-style-type: none"> Data-driven decision making for KPI analysis for service improvement Leadership & people management for leading cross-divisional IT teams Digital strategy: drafting & evaluating digital roadmaps Risk management: risk register management & IT risk mitigation Human Skills: <ul style="list-style-type: none"> Emotional intelligence for managing change & user resistance Communication for reporting & presenting to hospital management 	<ul style="list-style-type: none"> ISO 9001 training ITIL v4 training IT leadership coaching Data analytics upskilling Risk management workshop Digital hospital benchmarking
Digital Innovation & HR Development	<ul style="list-style-type: none"> ≥ 3 digital innovations realized/year $\geq 90\%$ IT HR competent per roadmap - 100% IT HR participating in development/year 	Tech Skills: <ul style="list-style-type: none"> AI & emerging technology literacy: AI/ML in the hospital context Human Skills: <ul style="list-style-type: none"> Creativity & innovation: impactful innovative ideas Critical thinking: evaluating innovation feasibility & impact Adaptability: keeping pace with global health technology developments Business Skills: <ul style="list-style-type: none"> Digital strategy for connecting innovation to hospital business needs Project management for structured innovation prototype execution 	<ul style="list-style-type: none"> Internal innovation incubation program Digital hospital benchmarking E-learning platform subscription Basic AI/ML training PERSI/ARRSI/ARSPT N conference participation Regular internal knowledge sharing

Roadmap

The roadmap is the final and culminating output of the entire sequence of analyses in this study. This roadmap has a dual-track nature, including both technology and IT human resources. The roadmap is constructed on the principle that the development of IT human resource competencies must precede the implementation of new technologies. This means that IT staff training and certification for a given system are scheduled at least one quarter before the system's go-live date, making sure that each newly launched technology has competent operators and accreditation. This principle is derived from the findings on the IT human resource gap in gap to innovation and is supported by the Bernard Marr framework. The roadmap begins with establishing a baseline in 2025 by assessing the teaching hospital's current state. The existing conditions are presented in Table 6.

Table 6. Baseline 2025

Component	Existing Condition	Status	Next Plan
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Component	Existing Condition	Status	Next Plan
Bridging BPJS	Already actively integrated	Existing	To be optimized
Mobile Apps	Already launched (v1: booking)	Existing	To be enhanced
Basic RME/EMR	Already available, including SOAP via AI Speech-to-Text	Existing	to be expanded across all modules
Ancillary Queue System (pharmacy, laboratory, radiology)	Already implemented	Existing	To be enhanced
HR Information System (leave, shift scheduling, payroll)	Already operational	Existing	To be developed
ISO 9001:2015	Already implemented, surveillance audit ongoing	Existing	to be maintained & improved

After outlining the existing conditions in 2025, the 2026–2029 roadmap is organized into four annual implementation phases, each signifying a distinct maturity level. Within each phase, IT HR competency development rows are deliberately positioned before the corresponding technology implementation rows, operationalizing the principle that human readiness precedes technological deployment. The roadmap is presented in Figure 2 as follows.

No.	Strategic Program	2026 FOUNDATION	2027 DEVELOPMENT	2028 EXPANSION	2029 EXCELLENCE
1	HIS, infrastructure, security & governance competency development <i>HIS technical training, ITIL v4, CompTIA Sec+, VMware/cloud cert, ISO 9001, IT leadership coaching</i>				
2	IT infrastructure foundation <i>Server & storage upgrade, IaaS expansion, PC refresh, mobile signal booster, hybrid cloud & IAM</i>				
3	IT governance, network security & accreditation foundation <i>IT governance documentation, ITIL v4, VLAN segmentation, SSL/TLS encryption, penetration testing, Starkes MRMK + HIMSS EMRAM L5</i>				
4	Integrated HIS for-patient journey — Phase 1 & employee performance system <i>EMR, pharmacy, lab, radiology, digital queue, employee performance & career management module</i>				
5	Mobile, payment, BPJS integration & advanced security competency <i>Mobile dev bootcamp, Flutter/React Native, OWASP, PCI-DSS, API + HL7 FHIR, BPJS regulatory, CISSP/CEH, ISO 27001 LA</i>				
6	New HIS — independently developed, audit trail & RBAC <i>Agile/Scrum development, dedicated server, IAM, encrypted storage, dev/staging/prod environment</i>				
7	Advanced mobile apps, bank payment gateway & BPJS claims automation <i>Android/iOS apps, host-to-host payment gateway, BPJS automation, private insurance integration</i>				
8	SIEM, zero-trust architecture & IT digital innovation forum <i>24/7 security monitoring, zero-trust network, incubation program, > 3 innovations/year</i>				
9	Starkes survey + ISO 9001 surveillance + HIMSS EMRAM Level 6 <i>Accreditation survey, ISO surveillance audit, integrated clinical system compliance</i>				
10	AI/ML literacy, digital strategy & JCI knowledge preparation <i>Basic AI/ML training, digital strategy, innovation portfolio management, JCI 8th Edition standards</i>				
11	Business intelligence, CDSS & AI/ML pilot + ISO 27001 certification <i>BI platform, clinical decision support system, AI/ML pilot implementation, full ISMS external audit</i>				
12	JCI 8th Edition + ISO 27001 + HIMSS EMRAM Level 7 + Strategic Plan review <i>Full international accreditation achievement + evaluation & preparation for 2030–2034 strategic cycle</i>				

Notes: ■ IT HR Training & Certification ■ Technology Implementation ■ Governance & Accreditation

Figure 2. Roadmap 2026-2029

The first phase, Foundation (2026), focuses on developing foundational IT HR competencies across all eight Bernard Marr competency domains, including HIS technical training, ITIL v4, CompTIA Security+, VMware/cloud certification, and IT leadership coaching, before deploying the corresponding infrastructure and systems. Technology deliverables in this phase include the server and storage infrastructure upgrade, IT governance formalization, network security baseline, the first phase of the integrated HIS for the patient journey, and the employee performance management system. Governance and accreditation preparation for Starkes 2024 MRMK and HIMSS EMRAM Level 5 also commences in this phase. The second phase, Development (2027), deploys the most complex technological cluster, which is solely feasible because of the HR foundation built in 2026. Competency development in this phase centers on mobile development, API and HL7 FHIR integration, BPJS regulatory literacy, and advanced security certifications, including CISSP/CEH and ISO 27001 Lead Auditor. Technology deliverables include the go-live of the independently developed new HIS with audit trails and RBAC, advanced mobile applications, the host-to-host bank payment gateway, BPJS claims automation, and a SIEM with a zero-trust architecture. The IT digital innovation forum is also formally established in this phase.

The third phase, Expansion (2028), focuses on full financial integration, the development of analytical competencies, and preparation for international certification. IT

HR development in this phase centers on AI/ML literacy and digital strategy competencies, which are prerequisites for implementing business intelligence, clinical decision support systems, and the AI/ML pilot. ISO 27001 external certification is targeted for achievement in this phase, building on the governance foundations set in 2026 and 2027. The fourth and final phase, Excellence (2029), marks the roadmap's peak achievement. IT HR preparation in this phase centers on JCI 8th Edition standards literacy and knowledge management, enabling the hospital to pursue JCI accreditation, HIMSS EMRAM Level 7, and final ISO 27001 surveillance alongside the AI/ML expansion. This phase also serves as the evaluation period for the 2025–2029 Strategic Plan and as the preparatory basis for the subsequent strategic cycle.

CONCLUSION

This study shows that HIS digital transformation readiness at a teaching hospital requires the deliberate integration of two mutually dependent strategy dimensions: technological strategy and IT HR strategy, operationalized through a four-phase roadmap spanning 2026 to 2029. The required technological strategy encompasses eight clusters derived from the Ward and Peppard framework, covering application development, infrastructure, network security and IT governance, and is implemented across four sequential phases: foundation, development, expansion and distinction. These clusters form an interconnected system in which infrastructure readiness is a prerequisite for application development, and application maturity is a prerequisite for advanced analytics and international accreditation. The IT HR strategy centers on a structured, phased competency development program mapped across Tech Skills, Human Skills, and Business Skills using the Bernard Marr Future Skills Framework. The critical finding is that the primary bottleneck to transformation readiness lies in Business Skills and Human Skills, specifically project management, regulatory literacy, digital strategy, and cross-divisional collaboration, rather than in Tech Skills alone, reframing the conventional assumption that IT investment alone drives transformation readiness. The combination of both strategies into a dual-track roadmap governed by the principle that IT HR competency development must precede each phase of technology implementation constitutes the direct answer to the research question. Digital transformation readiness is attained by disciplined, sequenced integration within a traceable, strategically cascading framework derived from the hospital's Strategic Plan, the Ward and Peppard IS/IT Strategy, the Balanced Scorecard, and the Bernard Marr Future Skills Framework, producing a roadmap replicable for other teaching hospitals in Indonesia. Future research is advised to evaluate the effectiveness of roadmap implementation after the Foundation phase to measure alignment between planned strategy and field execution, develop a digital maturity measurement instrument specifically designed for the tripartite functions of teaching hospitals, explore scalable IT HR competency development models suited to the budget constraints of public hospitals in Indonesia, and replicate this cascading framework across other teaching hospitals to strengthen the generalizability of the model.

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