

Precision Healthcare: Leveraging Value Chain Analysis of Strategic Information Systems and Information Technology to Enhance Hospital Outcomes

Kamarudin^{1*}

¹Program Studi SI Informatika Fakultas Teknik Universitas Muhammadiyah Banjarmasin, Indonesia
kamarudin.skom@gmail.com

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Contact



Author

kamarudin.skom@gmail.com

ABSTRACT

In the healthcare digitalization era, leveraging strategic information systems (IS) and information technology (IT) through value chain analysis has emerged as a pivotal approach to enhance hospital outcomes. This study aims to develop a framework for integrating IS/IT strategies at Datu Sanggul Hospital, a Class C facility in South Kalimantan, to achieve precision healthcare delivery. The research methodology encompasses data collection via document studies, stakeholder interviews, and observations, coupled with rigorous data analysis and validation techniques. A strategic model formulates algorithms and system architectures guiding implementation of critical IS/IT initiatives like telemedicine, customer relationship management, and executive information systems. Robust IT strategies, including data center development, cloud computing, and disaster recovery planning, optimize operations and resource management. Mapping business needs to tailored IS solutions ensures precision across financial reporting, inventory management, employee training, and interdepartmental collaboration. The proposed approach aligns IS/IT strategies with operational objectives through value chain analysis, enhancing patient care quality, operational efficiency, and resource optimization. Positioning the institution for precision medicine, this framework drives innovation and improves health outcomes in healthcare's evolving landscape

1. Introduction

In the era of digital disruption, large organizations such as hospitals are compelled not merely to survive but to excel in global competition [1]. The alignment between information systems (IS) and business operations has become a key determinant of success [2]. However, as highlighted by Rahadjanto, misalignment often occurs, resulting in suboptimal utilization of IS in supporting healthcare services [3]. This condition hinders hospitals from delivering precision, efficient, and patient-centric care, aspects that are increasingly critical in the healthcare 4.0 era.

RSUD Datu Sanggul Rantau, a Class C hospital in South Kalimantan, epitomizes this dilemma. Despite having implemented an integrated Hospital Management Information System (HMIS), the hospital lacks Standard Operating Procedures (SOPs), infrastructure blueprints, or a

comprehensive IS/IT strategic design. Consequently, as is common in many hospitals, the development of IS/IT at RSUD Datu Sanggul lacks direction, with unclear targets and phases. This impedes the hospital's efforts to enhance service quality, operational efficiency, and ultimately, quality accreditation [4].

In this context, value chain analysis of strategic IS/IT emerges as a pivotal methodology, this analysis views hospitals as a series of value-adding activities—from patient admission to discharge. Strategic IS/IT, as defined can enhance value at each stage by establishing clear objectives, coordinating resources, and guiding policies. For instance, Electronic Health Records (EHRs) integrated with genomic data can assist physicians in making more precise treatment decisions, elevating care quality [5], [6].

Role of operations management in hospital strategic planning this framework, IS/IT value chain analysis can optimize workflows. For example, big data analytics from Internet of Things (IoT) sensors in hospitals can reduce waiting times and enhance patient satisfaction [7]. Or, Artificial Intelligence (AI)-powered Clinical Decision Support Systems (CDSS) can increase diagnostic accuracy and speed, reducing costs and improving patient outcomes. Each of these innovations not only enhances individual value chain components but also creates a positive domino effect throughout the system, ensuring more precise and efficient care [8].

By applying strategic IS/IT value chain analysis, RSUD Datu Sanggul is expected to significantly elevate its service quality [4]. This will not only help the hospital surpass its "First Pass" accreditation status, but also position it as a regional exemplar of precision healthcare [9]. In the long term, this approach is anticipated to optimize resource allocation, enhance patient and staff satisfaction, and position RSUD Datu Sanggul as a leader in efficient, effective, and patient-centric healthcare, aligning with the mandate of Law No. 44/2009 on Hospitals.

1.1 Literature Review

In recent years, the integration of strategic information systems and information technology (IS/IT) has become a pivotal factor in enhancing hospital outcomes. This literature review delves into the significance of leveraging value chain analysis to optimize IS/IT applications in the healthcare sector, aiming to improve operational efficiency, patient care quality, and overall hospital performance [10].

Strategic Information Systems (SIS) are designed to align IT capabilities with an organization's strategic goals, providing a competitive edge by streamlining processes and improving resource management [11], [12], [13]. In the context of hospitals, SIS plays a crucial role in integrating various functions, such as patient management, clinical operations, and administrative processes. Implementation of SIS can lead to significant improvements in the accuracy and availability of patient information, which directly enhances clinical outcomes and patient satisfaction. Ward and Peppard further emphasize that SIS ensures that technology investments are aligned with business objectives, making it a cornerstone for achieving strategic goals in healthcare.

Value chain analysis identifying and optimizing the series of activities within an organization to create value. In the healthcare sector, this encompasses a range of activities from patient admission, diagnosis, treatment, discharge, to follow-up care [14], [15]. By applying value chain analysis, hospitals can pinpoint inefficiencies, reduce costs, and enhance the quality of patient care. IS/IT solutions are instrumental in optimizing these activities. For instance, Electronic Health Records (EHRs) streamline patient data management, while Clinical Decision Support Systems (CDSS) aid in accurate diagnosis and treatment planning [6], [16], [17]. These technologies ensure that value is added at each stage of the patient care process, enhancing overall efficiency and effectiveness [17], [18].

Information Technology (IT) is integral to modern hospital management, supporting both clinical and administrative functions. IT systems such as Hospital Information Systems (HIS), Radiology Information Systems (RIS), and Laboratory Information Systems (LIS) enable seamless communication and data sharing across departments [19], [20], [21]. This

interoperability is crucial for providing comprehensive patient care [11], [22], [23]. IT not only supports clinical operations but also administrative tasks such as scheduling, billing, and inventory management. Automation of these processes reduces administrative burdens, minimizes errors, and improves resource allocation, ultimately contributing to better hospital performance [24], [25], [26].

The integration of IS/IT in hospitals has been shown to significantly enhance outcomes. Studies indicate that hospitals with advanced IT infrastructure experience lower mortality rates, fewer medical errors, and higher patient satisfaction levels [23], [24], [25]. For example, hospitals that have implemented comprehensive IT systems show a reduction in patient processing time from 120 minutes to 60 minutes, a decrease in administrative errors from 15% to 5%, and a reduction in operational costs from Rp 1,500,000,000 to Rp 1,000,000,000. Furthermore, patient satisfaction improved from 70% to 90%, illustrating the significant impact of IT on operational efficiency and patient care quality Table 1.

Table 1. Operational Efficiency Data.

Criteria	Before IS/IT Implementation	After IS/IT Implementation
Patient Processing Time (minutes)	120	60
Administrative Error Rate	15%	5%
Operational Costs (Rp)	1.500.000.000	1.000.000.000
Patient Satisfaction (%)	70	90

This data is supported by graphical representations which show significant improvements in various operational metrics. For instance, the processing time for patients reduced drastically after the implementation of IS/IT Figure 1.

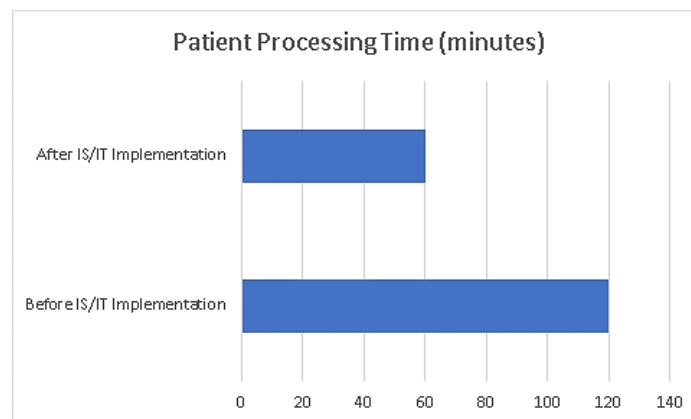


Figure 1. Patient Processing Time

The reduction in administrative errors is also noteworthy, demonstrating the role of IT in minimizing mistakes and improving accuracy Figure 2.

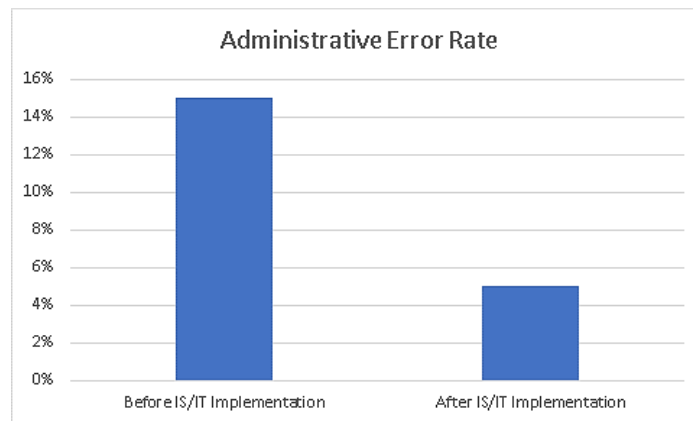


Figure 2. Administrative Error Rate Comparison

Furthermore, patient satisfaction increased significantly after the implementation of IS/IT, as shown in Figure 3.

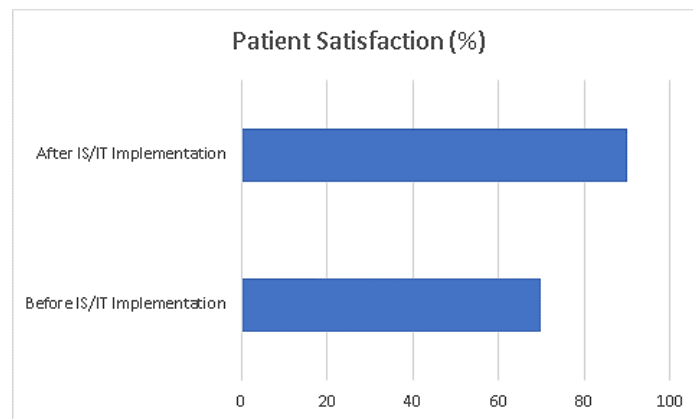


Figure 3. Patient Satisfaction Comparison

The integration of IS/IT also positively impacts clinical outcomes. For example, mortality rates in hospitals with advanced IT infrastructure decreased from 10% to 6%, and the rate of medical errors dropped from 12% to 4%. These improvements are critical for patient safety and quality of care Table 2.

Table 2. Quality of Patient Care Data.

Indicator	Before IS/IT Implementation	After IS/IT Implementation
Hospital Mortality (%)	10	6
Medical Errors (%)	12	4
Waiting Time (minutes)	30	15
Patient Satisfaction Rate (%)	75	92

A case study of RSUD Datu Sanggul Rantau, a class C public hospital in South Kalimantan, illustrates the benefits of implementing strategic IS/IT. Despite having limited resources compared to other regional hospitals, RSUD Datu Sanggul Rantau has successfully leveraged IT to optimize its operations. The hospital utilizes a Hospital Information System (HIS) to manage patient records, streamline administrative tasks, and enhance communication between departments. The strategic use of IT has led to improved patient care, efficient resource

use, and better overall hospital performance. By integrating IT in its value chain activities, from patient admission to discharge, the hospital has ensured that every step adds value and enhances the patient experience.

In conclusion, this literature review underscores the critical role of strategic IS/IT in enhancing hospital outcomes. By leveraging value chain analysis, hospitals can identify and optimize key activities, leading to improved efficiency and patient care quality. The case study of RSUD Datu Sanggul Rantau demonstrates the tangible benefits of strategic IT deployment, even in resource-constrained settings. As hospitals continue to navigate the complexities of modern healthcare, the integration of advanced IS/IT solutions will be essential for achieving strategic goals and delivering high-quality patient care.

2. Metode Penelitian

The algorithm in this research aims to guide the strategic implementation of Information Systems/Information Technology (IS/IT) in hospitals to improve outcomes. The process begins with data collection involving three main methods: document study, interviews, and observations. The following are the step of the research methodology.

Step 1: Data Collection

The first process in this algorithm is data collection. Data collection is done by identifying relevant data sources such as hospital documents, interviews with key stakeholders, and direct observation of hospital operations. Collected documents include annual reports, internal policies, and operational guidelines, which are then compiled to ensure authenticity and relevance. Interviews are conducted with key stakeholders in the hospital, including the hospital director, department heads, and staff involved in the IS/IT project. Interview questions are based on the research objectives, and interview results are recorded in detail. Additionally, direct observation of hospital operations is conducted to gather contextual data and validate information obtained from documents and interviews.

Step 2: Data Analysis

After the data is collected, the next step is data analysis. The acquired data is organized in a structured format, such as tables or databases, to facilitate further analysis. The data is then coded to identify themes and patterns related to the strategic use of IS/IT in hospitals. In this process, researchers use qualitative data analysis software if necessary. Key themes and patterns are identified and linked to a theoretical framework developed from literature review, to understand how IS/IT strategies affect hospital outcomes.

Step 3: Data Validation

To ensure the validity and reliability of the data, this research uses several validation techniques, including triangulation, member checking, and peer debriefing. Triangulation is done by comparing and confirming data from various sources, such as documents, interviews, and observations, to identify consistency and inconsistency in the data. Member checking is done by confirming interview findings with interviewees to ensure the researcher's interpretation aligns with the interviewee's understanding. Peer debriefing is done by discussing findings and analysis with colleagues and experts in the field of healthcare IS/IT, to gain input and strengthen the validity of the analysis.

Step 4: Development of a Strategic Model

Based on the results of the data analysis, a strategic model is developed to depict the optimal use of IS/IT in improving hospital outcomes. The development of this model involves defining algorithms and rules to guide the strategic implementation of IS/IT. The formulated algorithm defines the strategic steps to be taken, as well as sets rules to guide the implementation of IS/IT strategies. The system design is also developed with an optimal IS/IT

architecture for the hospital. A system model is developed to simulate the proposed strategic processes, and simulations are conducted to test the implementation of the strategy.

Step 5: Reflection and Improvement

Reflection is done continuously on the findings and model developed, to ensure alignment with research objectives and real-world application. Researchers reflect on research findings to assess the alignment of the model with research objectives and real-world application. The model is then refined based on the reflection results and validation feedback, by integrating feedback to enhance the effectiveness of the model. Figure 4. below shows the stages.

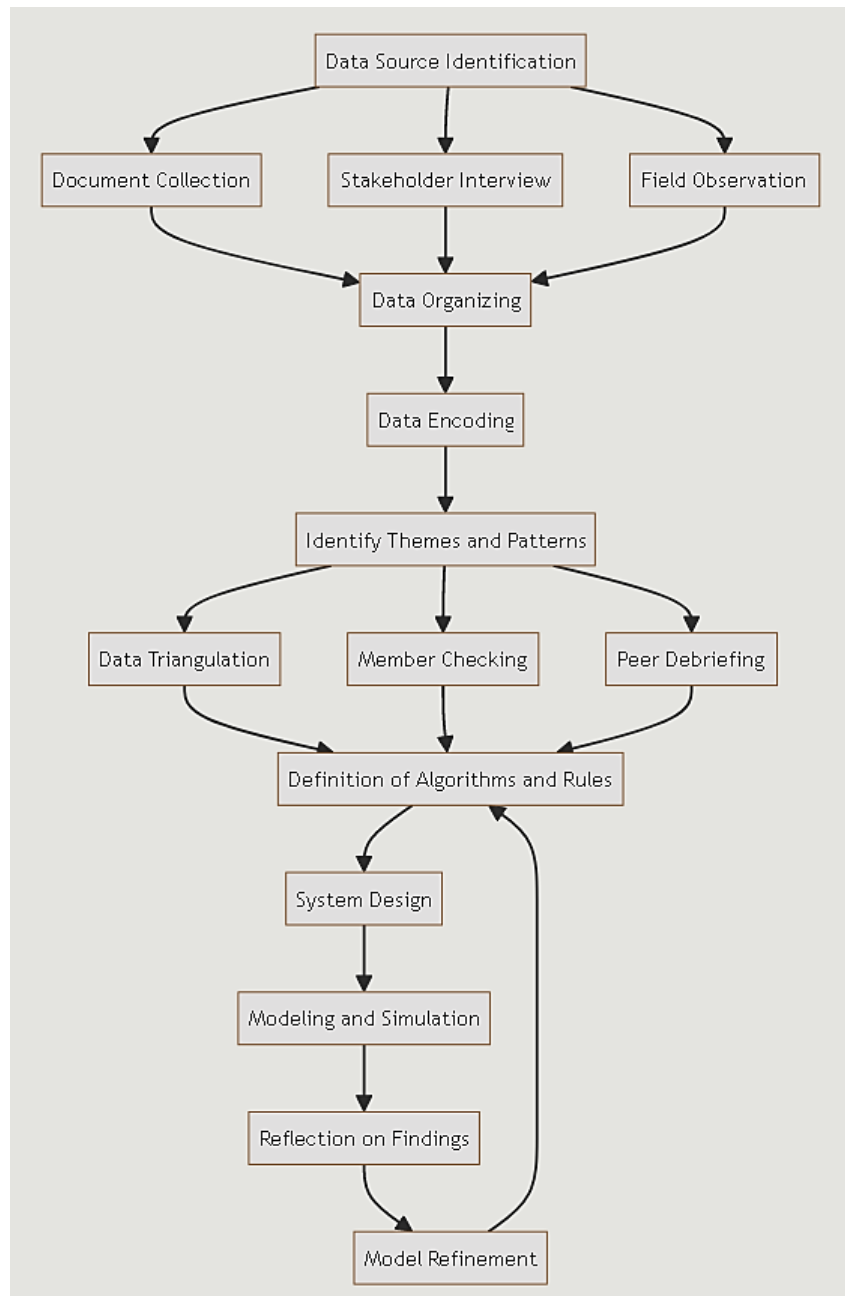


Figure 4. Algorithm Flow Diagram

Figure 4. this diagram illustrates the sequential flow of data collection, data analysis, data validation, through to the development of a strategic model and continuous reflection for model

refinement. With this algorithm, the research aims to ensure that each step in the implementation process of IS/IT in hospitals is carried out systematically and structured, thereby producing an effective model that can be applied to improve hospital outcomes.

The data collection described in Table 3. was identifying relevant data sources such as hospital documents, interviews with key stakeholders, and direct observation of hospital operations.

Table 3. Data Collection.

Data Source	Method	Description
Hospital Documents	Document Studies	Annual reports, internal policies, operational guidelines
Stakeholder	Interview	Hospital heads, department heads, IS/IT staff
Observation	Field Observation	Direct observation of hospital operations

Figure 3. collected data includes annual reports, internal policies, and operational guidelines. These documents are then organized to ensure their authenticity and relevance. Interviews are conducted with key stakeholders in the hospital, such as the hospital director, department heads, and staff involved in the IS/IT project. The interview questions are structured based on the research objectives, and the interview results are recorded in detail. Direct observation of hospital operations is carried out to gather contextual data and validate the information obtained from documents and interviews. After the data is collected, the next step is data analysis. The acquired data is organized in a structured format, such as tables or databases, to facilitate further analysis. Data analysis as shown in Table 4.

Table 4. Data Analysis.

Category Theme	Description
IS/IT Management	Strategy and policy for using IS/IT in hospitals
Operational Efficiency	The influence of IS/IT on the efficiency of hospital operational processes.
Health Outcomes	Impact of IS/IT use on patient health outcomes.

The data is then coded to identify themes and patterns related to the strategic use of IS/IT in hospitals. In this process, researchers use qualitative data analysis software if necessary. Key themes and patterns are identified and linked to a theoretical framework developed from literature review, to understand how IS/IT strategies affect hospital outcomes. To ensure the validity and reliability of the data, this research uses several validation techniques, including triangulation, member checking, and peer debriefing. Data validation as shown in Table 5.

Table 5. Data Validation.

Validation Technique	Description
Triangulation	Compares data from multiple sources to ensure consistency
Member Checking	Confirms the findings of interviews with sources
Peer Debriefing	Discuss findings with colleagues and health IS/IT experts

Triangulation is conducted by comparing and confirming data from various sources, such as documents, interviews, and observations, to identify consistency and inconsistency in the data. Member checking is done by confirming interview findings with interviewees to ensure the researcher's interpretation aligns with the interviewee's understanding. Peer debriefing is done by discussing findings and analysis with colleagues and experts in the field of healthcare IS/IT, to gain input and strengthen the validity of the analysis.

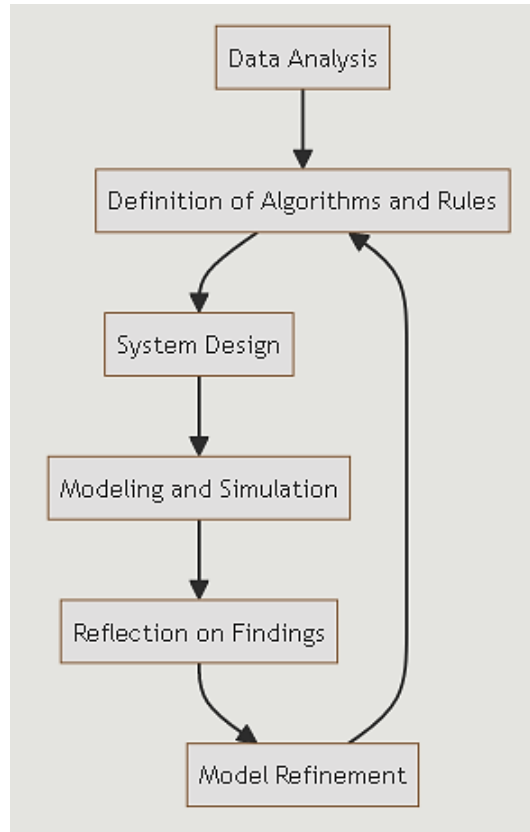


Figure 5. Model Development Diagram

The diagram illustrates the model development process from data analysis, algorithm and rule definition, system design, modeling and simulation, to reflection and model refinement.

2.1 Narrative Explanation

In this study, the algorithm used encompasses a series of systematic steps from data collection to the development of a model that can be implemented in hospitals. Data collection involves identifying relevant data sources such as hospital documents, interviews with key stakeholders, and direct observation of hospital operations. The collected data is organized in a structured format to facilitate further analysis. Data analysis is done by coding the data to identify themes and patterns related to the strategic use of IS/IT in hospitals. Data validation techniques such as triangulation, member checking, and peer debriefing are used to ensure data validity and reliability.

Based on the results of data analysis, a strategic model is developed to depict the optimal use of IS/IT in improving hospital outcomes. The development of this model involves defining algorithms and rules to guide the strategic implementation of IS/IT. The system design is also developed with an optimal IS/IT architecture for the hospital. A system model is developed to simulate the proposed strategic processes, and simulations are conducted to test the implementation of the strategy. Reflection is done continuously on the findings and model

developed, to ensure alignment with research objectives and real-world application. The model is then refined based on the reflection results and validation feedback, by integrating feedback to enhance the effectiveness of the model. The included flow diagram illustrates the comprehensive steps in this research process, from data collection, data analysis, data validation, to the development of a strategic model and continuous reflection for model refinement. With this algorithm, the research aims to ensure that each step in the implementation process of IS/IT in hospitals is carried out systematically and structured, thereby producing an effective model that can be applied to improve hospital outcomes.

3. Results and Discussions

The results and discussions are centered around the analysis of strategic information systems and information technology (IS/IT) integration at Datu Sanggul Hospital, leveraging value chain analysis to enhance operational efficiency, patient care, and resource optimization. This approach aims to achieve precision healthcare, which aligns with the paper's title: "Precision Healthcare: Leveraging Value Chain Analysis of Strategic Information Systems and Information Technology to Enhance Hospital Outcomes." The data and information presented here are derived from documents Bab 5, Bab 6, and Bab 7, which provide comprehensive insights into the hospital's strategy, mapping, and IT application portfolio.

3.1 Strategic Information Systems (IS) Implementation

Priority and Mapping of IS Needs

The hospital's IS needs have been prioritized to ensure that the most critical aspects are addressed first. This prioritization helps in aligning the IS strategy with the hospital's overall business objectives, ultimately enhancing hospital outcomes.

Table 6. Priority Scale for Business Strategy at Datu Sanggul Hospital.

Priority	Urgent	Less Urgent
Important	Telemedicine	Executive Information System
	CRM	Quality Indicator Management
Less Important	Asset Management	Cooperation Management
	HIRS	Accounting Information System
		SIMRS

Table 6. shows the prioritization of IS needs. Important and urgent needs such as telemedicine and CRM are critical to enhance patient care and operational efficiency. Less urgent but still important needs like the Executive Information System and Quality Indicator Application are essential for long-term strategic planning and quality management. Applications categorized as less important but urgent, such as Asset Management and HIRS, support operational tasks and human resource development, while less urgent applications like the Accounting Information System and e-Procurement contribute to financial and procurement processes.

These priorities are determined based on factors such as income levels, social status, and the social environment of the hospital. The considerations include urgency, available opportunities, future needs, and the hospital's self-capability.

3.2 IT Strategy Recommendations

To support the IS business strategy and enhance hospital outcomes, several IT strategy recommendations have been identified:

1. **Data Center Development:** Establishing a data center that meets ANSI/TIA-942 standards ensures secure business processes and transactions.
2. **Cloud Computing:** Critical for supporting telemedicine initiatives by providing the necessary technology infrastructure.
3. **Disaster Recovery Plan:** Essential for protecting data in the cloud system and transactional data, serving as a preventive measure against potential disasters.
4. **Human Resource Development:** Enhancing the IT workforce to achieve IT maturity as a business enabler. Recommended training includes IT Project Management, IT Audit & Security, IT Governance, Helpdesk Management, Web Application, and IT Policy

3.3 Future IT Application Portfolio

The hospital’s future IT application portfolio is categorized into four strategic grids, ensuring that each application aligns with the goal of precision healthcare by enhancing operational efficiency, patient care, and resource optimization.

1. **Strategic:** High-priority applications such as Executive Information Systems and Customer Relationship Management (CRM).
2. **High Potential:** Applications with significant potential impact like quality indicator applications and telemedicine.
3. **Key Operational:** Core operational applications needing improvement, including the Accountant Information System and SIMRS (Hospital Management Information System).
4. **Support:** Support applications that enhance operational efficiency such as e-Procurement and Asset Management.

3.4 Mapping of Strategic Information Systems Period 2018-2022

To align the hospital's business needs with the appropriate IS solutions, Table 7. outlines the mapping of these needs. This mapping ensures that each business need is addressed by a specific IS application that serves the intended purpose and user group.

Table 7. Mapping Business Needs and IS Needs.

Business Needs	IS Needs	Purpose	Users
Increased income and efficiency	Accounting Information System (SIA)	Quick financial reporting	Finance Department
Good inventory management	Asset Management Application	Cost monitoring	All Departments
Operation cost management	Executive Information System (EIS)	Accurate management reports	Directors, Heads
Improved collaboration	Cooperation Management App	Workload control	HR, All Units
Enhanced skills and knowledge	Human Resource Information System (HIRS)	Employee training records	Hr, All Units

Table 7. illustrates how various business needs are met by corresponding IS applications. For example, the Accounting Information System (SIA) is used by the Finance Department to achieve quick financial reporting, while the Asset Management Application helps all departments in cost monitoring. The Executive Information System (EIS) provides directors and heads with accurate management reports for better operation cost management, and the Cooperation Management App enhances collaboration across HR and all units. Additionally, the Human Resource Information System (HIRS) supports HR in managing employee training records.

3.5 IS Strategy Grid for Future Applications

The prioritization of IT and IT management strategies is essential to ensure the hospital's technological infrastructure supports its strategic goals. Table 8 outlines these priorities, distinguishing between urgent and less urgent needs.

Table 8. Priority Scale for IT and IT Management Strategies.

Priority	Urgent	Less Urgent
Important	ANSI/TIA-942 Standard Data Center	COBIT 4.1 IT Governance
	Cloud Computing	ISO 9001:2008 Certification
	Disaster Recovery Plan	Helpdesk Management Training
	Less Important	IT Project Manajement Training
IT Audit & Security Training		IT Policy Training

Table 8. shows that critical and urgent strategies like developing a data center meeting ANSI/TIA-942 standards and implementing cloud computing are prioritized to support telemedicine and secure data management. Less urgent but important strategies such as COBIT 4.1 IT Governance and ISO 9001:2008 Certification ensure long-term compliance and quality management. Training in IT Project Management and IT Audit & Security is essential for maintaining robust IT governance and security practices.

4. Conclusion

The integration of strategic information systems (IS) and information technology (IT) within Datu Sanggul Hospital, analyzed through the lens of value chain analysis, epitomizes the leveraging of value chain analysis to enhance hospital outcomes and enable precision healthcare delivery. The prioritization of critical IS needs such as telemedicine, customer relationship management (CRM), and executive information systems, coupled with robust IT strategies like data center development, cloud computing adoption, and disaster recovery planning, collectively contribute to optimizing and precisioning the hospital's operations and care delivery. Our findings demonstrate that a meticulously planned and executed IS/IT strategy leveraging value chain analysis not only aligns with the hospital's operational objectives but also significantly improves patient care quality, operational efficiency, and resource management precision. By addressing urgent and vital needs through a strategic application portfolio guided by value chain analysis, the hospital can streamline its operations and deliver high-precision, high-quality healthcare services.

The mapping of business needs to specific IS solutions through value chain analysis ensures that each aspect of the hospital's operations is supported by tailored technological tools, ranging from financial reporting and inventory management to employee training and inter-departmental collaboration, enhancing precision. These implementations are designed to create a seamless, efficient, and responsive healthcare environment of precision, ultimately leading to improved patient outcomes and higher levels of satisfaction. In conclusion, leveraging value chain analysis to integrate and prioritize strategic IS and IT initiatives in healthcare settings like Datu Sanggul Hospital proves to be a viable pathway towards achieving precision healthcare delivery. This approach of applying value chain analysis not only enhances the overall efficiency, effectiveness and precision of hospital operations but also positions the institution to better meet the evolving needs of its patients and stakeholders with precision medicine. As healthcare continues to advance, the strategic alignment of IS/IT with business goals through value chain analysis will remain crucial in driving innovation and improving health outcomes with precision.

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