

Challenges and Benefits of Implementing Smart Hospital Systems in Specialized Orthopedic Centers: A Systematic Review

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Abstract

The increasing complexity of healthcare services has encouraged specialized orthopedic centers to adopt smart hospital systems as an approach to improve service integration, operational efficiency, and patient-centered care. However, the implementation of these systems remains challenging due to technological, organizational, financial, and human resource limitations. This study aims to explore the benefits and challenges of implementing smart hospital systems in specialized orthopedic centers by examining their contributions to healthcare performance, operational processes, and patient experience. This research employed a systematic literature review approach by analyzing relevant studies related to smart hospitals, digital transformation, artificial intelligence, hospital information systems, and orthopedic healthcare services. A total of 25 studies were selected through a PRISMA-based screening process from an initial 200 identified records. The findings indicate that smart hospital systems provide significant benefits, including improved workflow coordination, faster access to medical information, enhanced clinical decision-making, increased surgical precision through advanced technologies, and improved continuity of rehabilitation care. Nevertheless, several challenges were identified, including limited infrastructure, high implementation costs, interoperability issues, data reliability concerns, and the need for user adaptation and training. In conclusion, smart hospital systems support more efficient, integrated, and patient-oriented orthopedic healthcare services; however, successful implementation requires technological readiness, organizational commitment, and continuous improvement strategies.



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INTRODUCTION

The increasing complexity of healthcare services has encouraged hospitals to rethink how care is delivered, especially in specialized areas such as orthopedic centers where treatment involves multiple stages and continuous monitoring. Conventional systems often rely on processes that run separately, which can lead to delays, miscommunication, and inconsistent service quality. This situation becomes more critical in orthopedic care, where patients frequently require coordinated treatment from diagnosis to rehabilitation. As a response, the concept of smart hospitals has emerged, offering a more connected approach through the integration of digital systems. Research such as (Gani, 2024) and (Noor, 2021) shows that smart hospital systems combine infrastructure, information technology, and service design to create a more organized and responsive healthcare environment. These ideas align with broader

observations that healthcare systems need to move beyond fragmented approaches toward more integrated models .

The role of digital transformation becomes increasingly important as hospitals begin to adopt technologies that support both clinical and administrative activities. Systems such as electronic medical records, artificial intelligence, and digital platforms allow information to be accessed more easily and used more effectively. Studies by (Suyitno et al., 2026) and (Hilmy et al., 2025) show that digital transformation strengthens service performance and improves decision-making processes. At the same time, research by (Halm-Pozniak et al., 2023) and (Koay et al., 2026) highlights that the development of digital healthcare continues to grow, especially in orthopedic fields. This transformation is not only about adopting new tools, but also about changing how hospitals operate so they can respond more effectively to patient needs.

Operational efficiency becomes a key concern in this transformation because it directly affects how services are delivered. Inefficient systems can create long waiting times, duplication of work, and poor coordination between departments. Research by (Hasibuan et al., 2024), (Ramadhani et al., 2025), and (Prawasari et al., 2024) shows that the use of hospital information systems improves coordination, reduces errors, and supports faster service delivery. These findings are strengthened by (Sihole et al., 2024) and (Purwayanto et al., 2025), which highlight the importance of system evaluation and infrastructure readiness. When systems are properly integrated, hospitals are able to use their resources more effectively and provide services in a more timely manner.

Alongside efficiency, the use of advanced technologies also brings significant changes to how care is delivered in orthopedic settings. Tools such as augmented reality, robotics, and artificial intelligence support more precise and consistent outcomes. Research by (Fucentese & Koch, 2021) as well as (Salazar Carrasco et al., 2026), shows that visualization technologies improve accuracy during procedures. Meanwhile, Hu et al. (2025) explains that robotic systems enhance precision but require significant investment. Studies such as (Han et al., 2025), (Glinkowski et al., 2026), (Ounasser et al., 2024), and (Mohammed et al., 2024) further show that artificial intelligence improves diagnostic accuracy, although challenges related to validation and data quality remain.

The impact of smart hospital systems is also closely related to patient experience, which reflects the quality of healthcare services. Patients not only evaluate outcomes but also how services are delivered, including waiting time, communication, and continuity of care. Research by (Khodijah et al., 2025) shows that environmental and psychological factors influence patient satisfaction, while (Hilmy, Putranto, et al., 2026) highlights that structured and consistent care improves patient outcomes. In orthopedic services, where patients often require repeated visits and long-term treatment, these aspects become even more important. This aligns with the broader understanding that patient experience is shaped by how smoothly services are delivered .

Despite the growing development of smart hospital systems, several challenges still limit their implementation. Issues related to system integration, infrastructure readiness, high costs, and user adaptation continue to affect how these technologies are applied in practice. Research by (Hilmy, Shameela, et al., 2026) shows that incomplete integration can reduce system effectiveness, while Purwayanto et al. (2025) highlights infrastructure limitations as a major barrier. In addition, (Irwan et al., 2025) and Prawasari et al. (2024) show that user readiness and acceptance play an important role in determining whether systems are successfully adopted. These challenges indicate that implementing smart hospital systems requires more than just technology; it also requires organizational readiness and continuous adjustment.

Based on these conditions, there is still a need for research that examines the challenges and benefits of implementing smart hospital systems in a more specific context, particularly in specialized orthopedic centers. Existing studies tend to focus on individual aspects such as technology, efficiency, or patient outcomes, without fully connecting them into a single framework. Therefore, this study aims to explore how smart hospital systems influence healthcare performance by considering both their advantages and the challenges that arise during implementation. By bringing these aspects together, this study seeks to provide a more comprehensive understanding of how digital transformation shapes orthopedic healthcare services.

RESEARCH METHOD

This study adopts a systematic literature review approach to examine the benefits and challenges of implementing smart hospital systems at specialized orthopedic centers, with particular attention to operational efficiency and patient satisfaction. Rather than collecting primary data from a single healthcare institution, the review synthesizes findings from previously published studies addressing digital technology adoption and healthcare service delivery. This approach allows the study to examine smart hospital implementation across different aspects of orthopedic care, including administrative processes, clinical decision-making, surgical procedures, and rehabilitation. By examining evidence from multiple studies, the review seeks to identify how digital technologies support healthcare operations and the challenges that may arise during their implementation.

The conceptual framework of this study draws on three interconnected concepts: smart hospital systems, operational efficiency, and patient satisfaction at specialized orthopedic centers. Smart hospital systems refer to the integration of digital technologies, including electronic medical records, artificial intelligence, and telemedicine, into hospital operations and clinical services. Operational efficiency concerns the management of healthcare resources and processes to support timely, accurate, and coordinated service delivery. Patient satisfaction refers to patients' perceptions of healthcare quality, accessibility, communication, and continuity of care throughout their treatment. These concepts provide a basis for examining how smart hospital technologies may support operational efficiency and shape patient satisfaction across different stages of orthopedic care, from initial consultation and diagnosis to surgical treatment and rehabilitation.

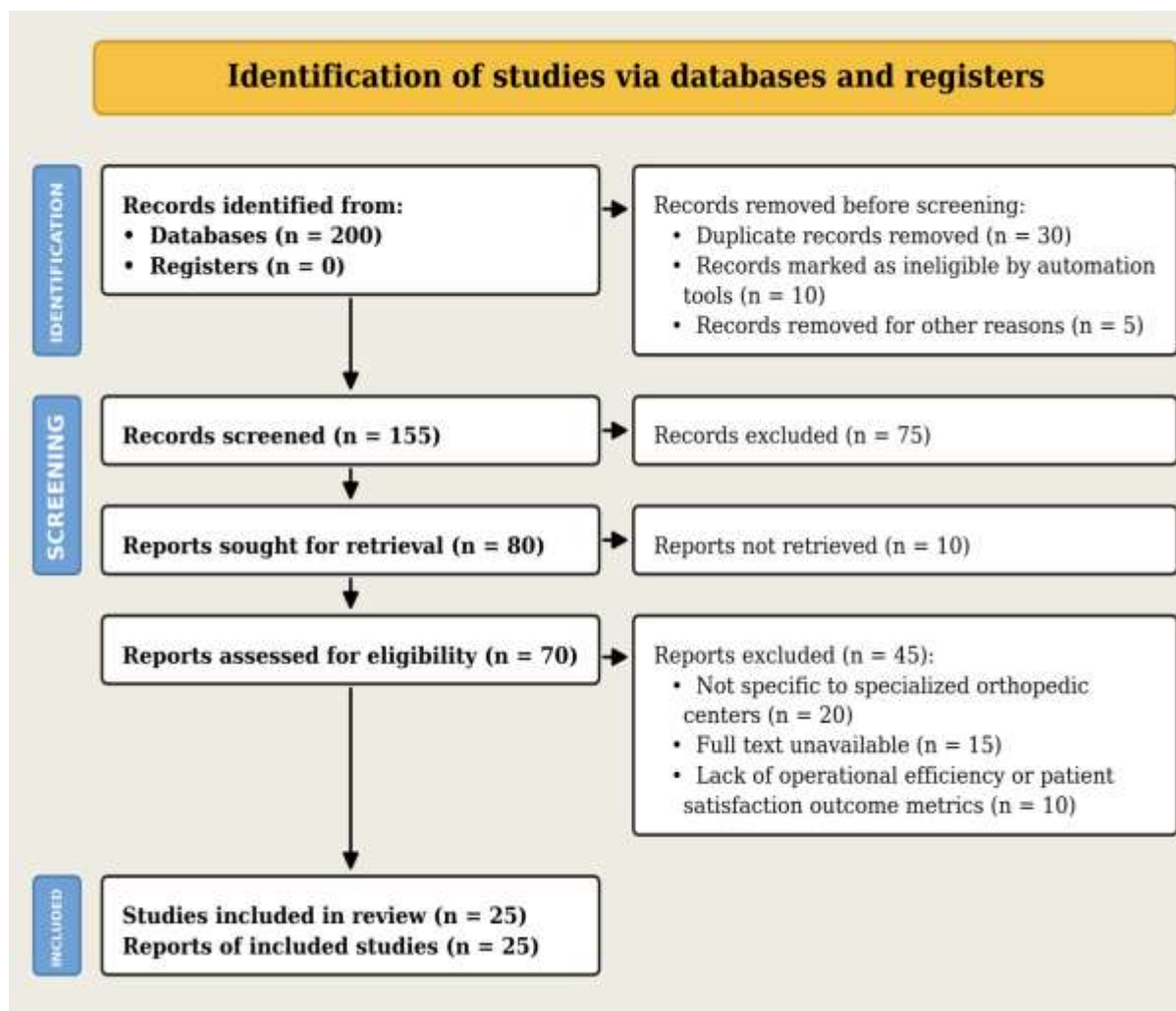


Figure 1. PRISMA Process

The initial stage begins with identifying relevant studies through database searches using keywords such as “smart hospital,” “digital transformation,” “operational efficiency,” and “physiotherapy services.” From this process, a total of 200 records are obtained, all sourced from academic databases, without additional records from other registers. Before moving to the next stage, several entries are removed 30 due to duplication, 10 identified as unsuitable through automated filtering, and 5 excluded for other reasons. After this early refinement, 155 records remain for further examination.

The screening phase involves reviewing titles and abstracts to determine their alignment with the research focus. Out of 155 records, 75 are excluded because they do not sufficiently relate to the topic. This leaves 80 articles that are considered potentially relevant and are then examined more closely. However, not all of these can be accessed in full, as 10 reports are unavailable. As a result, 70 articles proceed to the eligibility assessment stage.

At the eligibility stage, each full-text article is carefully evaluated based on predefined criteria, including relevance to smart hospital systems, operational efficiency, and patient satisfaction. During this process, a number of studies are excluded for various reasons, such as not directly addressing the research variables or lacking sufficient depth of analysis. After this selection, 25 studies remain and are deemed suitable for inclusion.

In the final stage, these 25 studies are included in the review and form the foundation of the analysis. The selected literature consists of both international and national publications,

allowing for a more balanced and well-rounded perspective. The PRISMA flow diagram visually summarizes this entire process, showing how the initial pool of studies is gradually narrowed down through systematic filtering. This step-by-step refinement strengthens the credibility of the study, ensuring that the conclusions are based on carefully selected and relevant sources.

Previous Studies

Table 1. Previous Studies

No	Research Title (Author, Year)	Research Method	Findings	Similarities / Differences
1	Fucentese, S. F., & Koch, P. P. (2021). A novel augmented reality-based surgical guidance system for total knee arthroplasty.	Experimental / Clinical study	AR improves surgical precision and intraoperative decision-making	Similar: smart technology / Different: surgical focus
2	Gani, R. A. (2024). Desain smart hospital dalam mendukung pelayanan kesehatan pada rumah sakit berbasis teknologi informasi.	Conceptual study	Smart hospital design supports integrated and efficient services	Similar: smart hospital / Different: design perspective
3	Glinkowski et al. (2026). Artificial intelligence in orthopaedics: Clinical performance, limitations, and translational readiness—A review.	Review	AI enhances diagnosis but faces validation and ethical challenges	Similar: AI healthcare / Different: clinical readiness focus
4	Halm-Pozniak et al. (2023). Best practice in digital orthopaedics.	Review	Digital systems improve orthopedic workflows and outcomes	Similar: digital health / Different: best practice approach
5	Han et al. (2025). Artificial intelligence in orthopedic surgery: Current applications, challenges, and future directions.	Review	AI improves planning and surgery but lacks standardization	Similar: AI implementation / Different: future direction focus
6	Hasibuan et al. (2024). Analisis strategi dalam optimalisasi pelayanan kesehatan melalui implementasi SIMRS.	Systematic review	SIMRS improves service quality and operational processes	Similar: system efficiency / Different: SIMRS focus
7	Hilmy et al. (2025). Analysis of the relationship between digital transformation influenced by technology and AI diagnosis.	Quantitative	Digital transformation strengthens healthcare service performance	Similar: digital transformation / Different: legal aspect
8	Hilmy et al. (2026). Analisis integrasi sistem informasi rumah sakit dan rekam medik elektronik.	Descriptive	Integration improves data accuracy and service coordination	Similar: smart system / Different: regulatory context
9	Hilmy et al. (2026). Patient outcomes and service delivery differences in physiotherapy care.	Systematic review	Service setting influences patient outcomes significantly	Similar: patient satisfaction / Different: physiotherapy focus

10	Hu et al. (2025). Robotic innovations in orthopedics.	Review	Robotics increases precision but requires high investment	Similar: smart technology / Different: robotics focus
11	Irwan et al. (2025). Implementasi artificial intelligence dalam administrasi rumah sakit.	Literature study	AI improves administrative efficiency and reduces workload	Similar: efficiency / Different: administrative focus
12	Khodijah et al. (2025). Impact of psychological conditions and physical environment on hospitality services.	Quantitative	Environment and psychology affect patient experience	Similar: patient satisfaction / Different: non-technology factors
13	Kim et al. (2022). SMART implantable devices for spinal implants.	Systematic review	Smart implants enable real-time monitoring but limited adoption	Similar: smart health / Different: implant technology
14	Koay et al. (2026). A scoping review of AI in orthopaedics.	Scoping review	AI research is growing rapidly in orthopedics	Similar: AI / Different: meta-review
15	Noor, S. (2021). Smart hospital information technology master plan.	Conceptual	IT planning is key for smart hospital development	Similar: smart hospital / Different: planning focus
16	Ounasser et al. (2024). AI in orthopedic surgery.	Systematic review	AI enhances outcomes but integration remains limited	Similar: AI / Different: implementation barrier
17	Prawasari et al. (2024). Pengaruh persepsi kegunaan dan kemudahan terhadap penggunaan SIMRS.	Quantitative	User perception strongly affects system adoption	Similar: system use / Different: TAM model
18	Priyadarshi et al. (2026). Smart healthcare technologies in rehabilitation.	Review	Smart tech improves rehabilitation outcomes and efficiency	Similar: smart healthcare / Different: rehab focus
19	Purwayanto et al. (2025). Analisis implementasi sistem informasi medis di Indonesia.	Literature review	Infrastructure and SDM are main challenges	Similar: system challenges / Different: Indonesia context
20	Ramadhani et al. (2025). Hubungan implementasi SIMRS dengan kinerja perawat.	Quantitative	SIMRS improves staff performance and service delivery	Similar: efficiency / Different: nursing focus
21	Salazar Carrasco et al. (2026). Orthopedic surgery assisted by mixed reality technology.	Systematic review	MR improves surgical visualization and accuracy	Similar: smart tech / Different: MR focus
22	Sihole et al. (2024). Strategi dan evaluasi sistem informasi kesehatan di Indonesia.	Literature review	Continuous evaluation needed for system optimization	Similar: system efficiency / Different: evaluation focus
23	Suyitno et al. (2026). Transformasi digital dalam administrasi rumah sakit.	Descriptive	Digitalization improves decision-	Similar: digital transformation /

			making and service quality	Different: management focus
24	Hilmy, et al., (2026). The Effect of Smart Hospital Implementation.	Literature review	Improves operational efficiency and physiotherapy patient satisfaction	Similar: smart hospital, physiotherapy focus / Different: Physiotherapy focus
25	(Waris & Hilmy, 2024) Analisis pemanfaatan rekam medis elektronik.	Quantitative (metode HOT-FIT)	Faktor human, organization, dan technology.	Similar: rekam medis elektronik (RME) / Different: quantitative method.

Source: Researcher (2026)

The synthesis of the 25 selected studies reveals that research related to smart hospital systems and digital transformation in healthcare, particularly in orthopedic settings, has progressed in a scattered manner rather than through an integrated perspective. A number of studies concentrate on conceptual and structural dimensions, such as Gani (2024) and Noor (2021), which underline the importance of system design and technological planning in building smart hospital environments. At the same time, other works emphasize technological innovation within orthopedic practice, including augmented reality, robotics, and artificial intelligence, as seen in Fucentese and Koch (2021) as well as Hu et al. (2025). Although these studies demonstrate clear advancements in precision and clinical performance, they tend to focus on isolated technological applications without situating them within a broader system-level framework. This pattern suggests that while individual components of smart hospital systems are well explored, their combined influence within specialized orthopedic centers remains insufficiently connected.

A second limitation emerges in the way operational efficiency is discussed across the literature. Many studies consistently report improvements in workflow, coordination, and data accuracy following the implementation of digital systems. For instance, findings from Hasibuan et al. (2024), Ramadhani et al. (2025), and Prawasari et al. (2024) highlight how hospital information systems contribute to better service delivery and staff performance. Similar patterns are also reflected in studies examining artificial intelligence in administrative and clinical contexts, such as Irwan et al. (2025), Han et al. (2025), and Mohammed et al. (2024). Despite these consistent findings, efficiency is frequently treated as an endpoint rather than as part of a broader causal chain. Only limited attention is given to how improvements in operational performance translate into outcomes that are meaningful from the patient's perspective. This indicates that the mediating role of efficiency within smart hospital systems is still not fully articulated.

Another notable gap appears in studies that address patient-related outcomes. Research focusing on patient experience and satisfaction tends to operate independently from technological and operational discussions. For example, Khodijah et al. (2025) emphasize environmental and psychological influences on patient perceptions, while (Hilmy Simanjuntak I. R. & Wahid K. R., 2026) explore differences in physiotherapy service models without incorporating digital transformation as a determining factor. Meanwhile, technology-driven studies such as Kim et al. (2022), Salazar Carrasco et al. (2026), and Glinkowski et al. (2026) demonstrate strong clinical and technical benefits but rarely extend their analysis to patient satisfaction or service perception. This separation indicates that patient-centered outcomes, especially within specialized orthopedic and physiotherapy contexts, are still rarely examined alongside technological and operational dimensions.

Taken together, these patterns highlight a clear research gap that aligns with the focus of this study. Existing literature has generated substantial insights into smart technologies,

system efficiency, and clinical innovation; however, these elements are often discussed in isolation. There is still limited understanding of how these components interact simultaneously, particularly in specialized orthopedic environments where advanced technologies, complex workflows, and patient-centered care intersect. Furthermore, several studies point to persistent challenges, including high implementation costs, data integration issues, limited system interoperability, and organizational readiness, as noted in works such as Purwayanto et al. (2025) and Ounasser et al. (2024).

Therefore, this study positions itself to address these gaps by examining both the challenges and the benefits of smart hospital implementation in a more interconnected manner. By bringing together technological, operational, and outcome-based perspectives within a single analytical framework, this research aims to provide a more complete understanding of how smart hospital systems shape efficiency and patient-related outcomes in specialized orthopedic centers.

RESULT AND DISCUSSION

Implementation of Smart Hospital Systems in Specialized Orthopedic Centers

The implementation of smart hospital systems in specialized orthopedic centers shows a clear shift in how healthcare services are organized and delivered. Instead of relying on separate and disconnected processes, hospitals are moving toward systems that are more integrated and coordinated. Studies such as Gani (2024) and Noor (2021) explain that this transformation starts from how hospitals are designed and how technology is planned from the beginning. In orthopedic settings, this becomes especially important because treatments often involve multiple stages, from diagnosis to surgery and rehabilitation, all of which need to be well connected.

As these systems begin to take shape, hospital information systems become one of the most important elements supporting daily operations. Research from Hasibuan et al. (2024), Ramadhani et al. (2025), and Prawasari et al. (2024) shows that digital systems help simplify administrative work, improve coordination between units, and make patient data easier to access. When information is available quickly and accurately, healthcare staff can respond faster and avoid unnecessary delays. At the same time, studies like Sihole et al. (2024) and Purwayanto et al. (2025) remind us that these systems still need regular evaluation, because not all hospitals have the same level of readiness or infrastructure.

In orthopedic care, the use of advanced technologies adds another layer to this transformation. Tools such as augmented reality, robotics, and data-driven systems are beginning to change how procedures are carried out. For example, research by Fucentese and Koch (2021) shows how augmented reality can help surgeons see more clearly during operations. Similar developments are seen in mixed reality technologies discussed by Salazar Carrasco et al. (2026) and robotic systems explored by Hu et al. (2025). On the diagnostic side, studies such as Han et al. (2025), Glinkowski et al. (2026), and Mohammed et al. (2024) show how technology can support more accurate and faster clinical decisions, even though its use is still developing in many places (Hu et al., 2025).

Beyond surgery and diagnosis, smart hospital systems are also influencing long-term care and rehabilitation. Technologies such as smart implants, discussed by (Kim et al., 2022), allow doctors to monitor patient conditions more closely over time. In rehabilitation, studies like (Priyadarshi et al., 2026) show that digital tools can make therapy more flexible and responsive to patient needs. This is particularly relevant in orthopedic centers, where recovery often takes time and requires consistent monitoring. Even so, not all hospitals are able to adopt these technologies at the same pace, often due to cost and technical limitations.

From an organizational perspective, how these systems are introduced and managed plays a major role in their success. Research by Hilmy et al. (2025) and Suyitno et al. (2026)

shows that digital transformation can improve service performance when it is supported by clear strategies and proper management. In addition, Irwan et al. (2025) points out that technology can reduce administrative burden, giving healthcare workers more time to focus on patients. However, challenges still appear, especially when systems are not fully integrated or when staff are not yet familiar with new technologies, as discussed by Hilmy et al. (2026).

Even with all these developments, the implementation of smart hospital systems is not always straightforward. Some hospitals face difficulties related to high costs, limited infrastructure, and the need for staff adaptation. Studies such as Ounasser et al. (2024) and Koay et al. (2026) highlight that while technology is advancing quickly, its real-world application still varies widely. At the same time, research from Khodijah et al. (2025) and Hilmy et al. (2026) shows that patient experience remains an important part of this transformation. In the end, implementing smart hospital systems in orthopedic centers is not only about adopting new technology, but also about making sure that these changes truly support both healthcare providers and patients in a meaningful way.

Benefits of Smart Hospital Technologies in Orthopedic Healthcare Services

The benefits of smart hospital technologies in orthopedic healthcare services become clearer when looking closely at how they reshape the overall flow of care. In orthopedic centers, patients often move through several stages, starting from consultation, imaging, surgery, and continuing into rehabilitation. When these stages are supported by connected systems, the entire process feels more organized and less fragmented. Research by Gani (2024) shows that a technology-based hospital design helps align physical space with digital systems, allowing information to move smoothly between departments. In a similar direction, Noor (2021) highlights that proper planning of information systems plays a major role in ensuring that all units operate in sync. In practice, this means fewer repeated steps, less confusion for patients, and a more coordinated experience from admission to discharge.

A more detailed look at information management shows how important digital systems are in everyday hospital activities. Orthopedic care relies heavily on accurate patient data, such as imaging results, medical history, and treatment plans. Studies by Hasibuan et al. (2024), Ramadhani et al. (2025), and Prawasari et al. (2024) explain that hospital information systems help reduce duplication of data, minimize documentation errors, and make it easier for healthcare workers to access what they need without delay. This becomes especially useful in busy clinical settings, where quick decisions are often required. At the same time, findings from Sihole et al. (2024) and Purwayanto et al. (2025) suggest that continuous system evaluation is still necessary, since differences in infrastructure and user readiness can affect how well these systems perform in real situations.

The role of smart technologies becomes even more impactful, particularly in procedures that require high precision. Orthopedic surgery often deals with complex structures, where even small errors can affect outcomes. Research by Fucentese and Koch (2021) shows that augmented reality allows surgeons to visualize internal structures more clearly during operations, helping them make more accurate movements. This is supported by findings from Salazar Carrasco et al. (2026), where mixed reality systems provide real-time guidance throughout surgical procedures. Robotics, as discussed by Hu et al. (2025), adds another layer of control, making procedures more consistent. On the diagnostic side, studies by Han et al. (2025), Glinkowski et al. (2026), Mohammed et al. (2024), and Koay et al. (2026) show that digital tools can assist in identifying conditions more quickly and accurately, although their use still depends on data quality and system reliability.

The advantages of smart hospital technologies continue into the recovery phase, which is a critical part of orthopedic care. Patients often require long-term monitoring and repeated therapy sessions, making consistency and adaptability essential. Research by Kim et al. (2022) shows that smart implants can track patient conditions in real time, allowing doctors to detect

issues earlier and adjust treatment plans when needed. Meanwhile, Priyadarshi et al. (2026) explains that digital rehabilitation tools can adapt therapy programs based on patient progress, making treatment more personalized. Studies such as Hilmy et al. (2026) further highlight that well-structured service systems can improve patient outcomes, especially when care is delivered consistently over time. These developments show that technology supports not only treatment but also long-term recovery.

From an operational standpoint, these technologies bring noticeable improvements to how hospitals manage their workload and resources. Routine administrative tasks, which used to consume a lot of time, can now be handled more efficiently. Research by Irwan et al. (2025) shows that digital systems can simplify administrative processes, reducing manual work and allowing staff to focus more on patient care. Findings from Suyitno et al. (2026) and Hilmy et al. (2025) also indicate that better access to data improves decision-making and helps hospitals respond more quickly to changing conditions. In addition, studies like Ounasser et al. (2024) and Glinkowski et al. (2026) suggest that while these technologies offer clear advantages, their implementation still requires careful adjustment to fit real clinical environments.

All these improvements come together in how patients experience healthcare services. When systems work well, patients notice the difference. They spend less time waiting, receive clearer information, and feel more confident in the care they are getting. Research by Khodijah et al. (2025) shows that both the environment and the way services are delivered influence how patients feel during treatment. At the same time, studies such as Hilmy et al. (2026) and Ramadhani et al. (2025) indicate that well-organized systems lead to better service quality and improved patient outcomes. Overall, the benefits of smart hospital technologies are not limited to technical improvements, but are also reflected in a more comfortable, reliable, and satisfying experience for patients undergoing orthopedic care.

Challenges in Adopting Smart Hospital Systems in Orthopedic Settings

The process of adopting smart hospital systems in orthopedic settings does not always run as smoothly as expected. Many hospitals face difficulties right from the beginning, especially when trying to fit new technologies into systems that have already been used for years. Research by Gani (2024) and Noor (2021) shows that without proper preparation, digital systems can feel out of place and may not support daily activities as intended. In orthopedic services, where coordination between different stages of care is very important, this mismatch can easily disrupt the flow of work. Studies like Halm-Pozniak et al. (2023) and Koay et al. (2026) also point out that even though technology is advancing quickly, not every hospital is able to apply it in the same way.

Another issue that often comes up is how different systems connect with each other. In reality, many hospitals do not implement all technologies at once, which leads to gaps between systems. Research by Hilmy et al. (2026) shows that integration between systems, especially between medical records and other platforms, is still a common problem. This is supported by findings from Purwayanto et al. (2025) and Sihole et al. (2024), where differences in infrastructure make it hard for systems to fully work together. Even when hospitals already have digital systems, studies like Hasibuan et al. (2024) and Ramadhani et al. (2025) show that the benefits are not always fully felt if those systems are not properly connected.

Cost is another factor that cannot be ignored. Many of the technologies used in orthopedic care, such as robotic systems or smart implants, are expensive and require ongoing maintenance. Research by Hu et al. (2025) shows that even though robotics can improve surgical precision, the high cost makes it difficult for many hospitals to adopt. The same thing appears in the study by Kim et al. (2022), where smart implants are still not widely used because of financial limitations. Studies like Priyadarshi et al. (2026) also show that advanced rehabilitation technologies depend heavily on available resources. Even technologies like

augmented reality and mixed reality, discussed by Fucentese and Koch (2021) as well as Salazar Carrasco et al. (2026), face similar barriers when funding is limited.

Beyond financial issues, people also play a big role in whether these systems work well or not. Technology can only help if the people using it feel comfortable and understand how to use it. Research by Prawasari et al. (2024) shows that users are more likely to adopt a system if they find it easy and useful. At the same time, Irwan et al. (2025) explains that while technology can reduce workload, it also requires staff to learn new ways of working. Studies by Suyitno et al. (2026) and Hilmy et al. (2025) show that without proper support and training, even good systems may not be used effectively.

There are also challenges when these technologies are applied directly in clinical situations. Even though many studies show positive results, not all systems are fully ready to be used in everyday practice. Research by Han et al. (2025), Glinkowski et al. (2026), and Ounasser et al. (2024) shows that technologies like artificial intelligence still need further testing to ensure they are reliable. Similarly, Mohammed et al. (2024) highlights that the accuracy of these systems depends heavily on the quality of data used. In orthopedic care, where precision is very important, even small uncertainties can make healthcare professionals hesitant to rely on these tools.

In the end, these challenges can also be felt by patients. When systems are not fully integrated or when staff are still adapting, patients may experience delays or inconsistencies in service. Research by Khodijah et al. (2025) shows that patient experience is influenced not only by treatment results but also by how services are delivered. Meanwhile, Hilmy et al. (2026) highlights how important consistency is, especially in physiotherapy where patients need regular care. Studies like Ramadhani et al. (2025) also show that system performance affects service quality. All of this shows that adopting smart hospital systems is not just about installing new technology, but about making sure everything works well together in real situations.

The Role of Digital Transformation and AI in Orthopedic Care

Digital transformation in orthopedic care is not simply about introducing new tools, but about reshaping how services are organized and delivered from end to end. Hospitals begin to rely more on connected systems that allow information to move quickly and support more informed actions. Findings from Suyitno et al. (2026) show that when data becomes easier to access, decisions can be made with greater clarity and speed. A similar view is presented by Hilmy et al. (2025), where technology is seen as a driving force that strengthens overall service performance. In orthopedic settings, this shift is particularly meaningful because treatment decisions often depend on detailed and timely clinical information.

The presence of artificial intelligence adds another dimension to this transformation, especially in how conditions are identified and evaluated. Research by Mohammed et al. (2024) explains that AI-based systems are able to process complex medical data and support more precise detection of orthopedic problems. Meanwhile, Ounasser et al. (2024) describes how these technologies assist in planning surgical procedures by offering deeper analytical insights. This kind of support allows healthcare professionals to approach cases with a clearer understanding, although its effectiveness still depends on the reliability of the data being used.

In the operating room, technological developments have begun to change how procedures are carried out. Tools that provide visual assistance, such as augmented and mixed reality, offer new ways for surgeons to navigate complex anatomical structures. Studies by Fucentese and Koch (2021) demonstrate how enhanced visualization can improve precision during surgery. This is reinforced by findings from Salazar Carrasco et al. (2026), where real-time guidance helps reduce uncertainty in surgical steps. These technologies do not replace clinical expertise, but they provide an additional layer of support that can make procedures more controlled and predictable.

The influence of digital transformation continues beyond surgical intervention and extends into recovery and follow-up care. Orthopedic patients often require ongoing monitoring, and digital tools help make this process more adaptive. Research from Priyadarshi et al. (2026) shows that rehabilitation programs can be adjusted based on individual progress, allowing treatment to remain aligned with patient needs. At the same time, Kim et al. (2022) highlights how smart implants provide continuous feedback on patient conditions, offering valuable insights for long-term care. This creates a more responsive approach where treatment evolves alongside recovery.

On the operational side, digital transformation also changes how hospitals manage their internal activities. Administrative processes that were once time-consuming can now be handled more efficiently through automated systems. Findings from Irwan et al. (2025) indicate that reducing routine administrative work allows healthcare staff to focus more on direct patient interaction. In addition, studies such as Hasibuan et al. (2024) and Ramadhani et al. (2025) show that better coordination across departments improves service flow and minimizes delays. This creates a working environment where tasks are handled more smoothly and efficiently.

These changes also shape how care is perceived by patients. The way services are delivered becomes just as important as the clinical results themselves. Research by Khodijah et al. (2025) suggests that patient impressions are influenced by clarity, comfort, and how well services are organized. Meanwhile, Hilmy et al. (2026) points out that consistent and well-managed care contributes to better outcomes, particularly in physiotherapy where continuity is essential. Altogether, digital transformation and artificial intelligence do not only improve technical performance, but also reshape how orthopedic care is experienced in a more structured and responsive way.

Integration of Smart Hospital Systems for Improving Healthcare Performance

The integration of smart hospital systems in orthopedic healthcare is not just about combining technologies, but about creating a way of working where everything connects smoothly. Hospitals are gradually moving away from separated processes toward systems that are more unified and easier to manage. Research by Gani (2024) and Noor (2021) shows that this starts from how hospitals are designed and how technology is planned from the beginning. When these elements are aligned, services no longer feel fragmented. This is also supported by Halm-Pozniak et al. (2023), who describe how digital practices can improve coordination in orthopedic care, although not all hospitals reach the same level of integration.

When integration works well, it becomes very visible in daily operations. Tasks that used to take longer can be completed more quickly because information is easier to access and share. Studies by Hasibuan et al. (2024), Ramadhani et al. (2025), and Prawasari et al. (2024) show that connected systems help reduce mistakes and improve coordination between staff. At the same time, findings from Sihole et al. (2024) and Purwayanto et al. (2025) remind us that integration depends not only on the system itself, but also on infrastructure and readiness. If one part is not ready, the whole system may not work as expected.

Integration becomes even more meaningful because it directly affects how care is delivered. Orthopedic procedures require precision, and combining different technologies helps support that. Research by Fucetese and Koch (2021), along with Salazar Carrasco et al. (2026), shows how visualization tools can improve accuracy during surgery. Meanwhile, Hu et al. (2025) explains that robotics helps make procedures more controlled and consistent. Studies such as Han et al. (2025), Glinkowski et al. (2026), Ounasser et al. (2024), and Mohammed et al. (2024) also show that combining data-driven systems with clinical practice can support more accurate diagnoses, even though challenges still exist in terms of data quality and system reliability.

Integration is also important beyond the operating room, especially in recovery and follow-up care. Orthopedic patients often need continuous treatment, and connected systems

help ensure that care remains consistent over time. Research by Kim et al. (2022) shows that smart implants allow ongoing monitoring, while Priyadarshi et al. (2026) explains that digital rehabilitation tools can adjust treatment based on patient progress. Findings from Hilmy et al. (2026) further highlight that when services are well connected, patients tend to achieve better outcomes because their care is more consistent and structured.

From a broader perspective, integration also affects how hospitals are managed. When systems are connected, decision-making becomes easier because information is complete and available in real time. Research by Suyitno et al. (2026) shows that digital transformation improves how hospitals plan and respond to different situations. Similarly, Hilmy et al. (2025) explains that performance improves when systems are used effectively. In addition, Irwan et al. (2025) highlights that administrative work becomes lighter, allowing staff to focus more on patient care. Still, as noted by Hilmy et al. (2026), integration also requires alignment with policies and regulations, which can sometimes slow down implementation.

The real impact of integration can be seen from the patient's point of view. When everything works together, patients experience fewer delays, clearer communication, and more organized services. Research by Khodijah et al. (2025) shows that patient satisfaction is closely linked to how services are delivered, not just the outcome of treatment. At the same time, studies such as Koay et al. (2026) and Mohammed et al. (2024) suggest that ongoing technological development continues to influence service quality. Overall, integration creates a system where care becomes more connected, more efficient, and easier for both patients and healthcare providers, even though achieving this level of coordination takes time and continuous effort.

The findings from the 25 selected studies show that the development of smart hospital systems in orthopedic healthcare does not happen all at once, but grows gradually as hospitals adjust both their structure and daily routines. Many hospitals are still in the middle of this transition, trying to move from systems that work separately toward ones that are more connected. Research by Gani (2024) and Noor (2021) explains that this process often begins from the way hospitals are designed and how technology is planned from the start. When planning is done carefully, each part of the hospital from administration to treatment areas can support one another instead of working on its own. In orthopedic centers, this becomes even more important because patient care usually involves several stages that must be linked smoothly, starting from diagnosis, continuing to treatment, and ending with rehabilitation.

A major advantage that repeatedly appears across the studies is the improvement in how work is organized and carried out. When hospitals start using connected systems, tasks that used to take longer can be completed more quickly and with fewer mistakes. Studies by Hasibuan et al. (2024), Ramadhani et al. (2025), and Prawasari et al. (2024) show that hospital information systems help simplify documentation, improve communication between staff, and make patient data easier to access. This reduces confusion and allows healthcare workers to focus more on their actual responsibilities. At the same time, research by Sihole et al. (2024) and Purwayanto et al. (2025) highlights that these improvements only happen when systems are maintained properly and supported by adequate infrastructure. If one part of the system does not function well, it can affect the entire workflow.

Another important benefit can be seen in how technology supports more accurate and consistent decision-making. In orthopedic care, small differences in judgment can have a big impact, so having additional support becomes very valuable. Research by Fucetese and Koch (2021) shows that visualization tools help doctors see structures more clearly, which improves precision during procedures. This is reinforced by findings from Salazar Carrasco et al. (2026), where real-time guidance helps reduce uncertainty. In addition, Hu et al. (2025) explains that robotic systems make movements more stable and controlled. Studies such as Han et al. (2025), Glinkowski et al. (2026), Ounasser et al. (2024), and Mohammed et al. (2024) also show that

data-driven systems can help identify conditions more quickly and accurately, although they still depend heavily on the quality of the data used.

The role of these systems continues after treatment, especially during recovery, where patients often need long-term care. Orthopedic patients usually go through repeated therapy sessions, so consistency becomes very important. Research by Kim et al. (2022) shows that smart implants can monitor patient conditions continuously, allowing doctors to detect changes earlier. Meanwhile, Priyadarshi et al. (2026) explains that digital rehabilitation tools can adjust therapy programs based on patient progress, making treatment more flexible. Findings from Hilmy et al. (2026) also highlight that when care is delivered in a structured and consistent way, patients tend to recover better. This shows that the impact of smart hospital systems is not limited to one stage, but extends throughout the entire patient journey.

Even with these advantages, the studies also point out several challenges that make implementation more complicated. One of the biggest issues is how to connect different systems so they can work together without problems. Research by Hilmy et al. (2026) shows that when systems are not fully integrated, they can actually slow down work instead of improving it. This is supported by findings from Purwayanto et al. (2025) and Sihole et al. (2024), where differences in infrastructure and system standards create barriers. In many cases, hospitals still need to combine digital systems with manual processes, which reduces efficiency and creates extra work.

Cost and human readiness also become important factors that influence how far these systems can be implemented. Studies by Hu et al. (2025) and Kim et al. (2022) show that advanced technologies require significant investment, making them difficult to adopt in all hospitals. On the other hand, research by Prawasari et al. (2024) and Irwan et al. (2025) highlights that even when systems are available, they may not be used effectively if staff are not familiar with them. Findings from Suyitno et al. (2026) and Hilmy et al. (2025) further show that strong management and proper guidance are needed so that technology can actually support daily work instead of becoming an additional burden.

From the patient's perspective, the influence of these systems is felt through how services are delivered. Patients tend to notice whether services run smoothly, whether information is clear, and whether they have to wait too long. Research by Khodijah et al. (2025) shows that comfort and clarity play a big role in shaping patient experience. When systems are well connected, patients usually experience more organized care and fewer disruptions. However, if implementation is incomplete, problems such as delays or inconsistent service can still occur. Studies such as Koay et al. (2026) and Mohammed et al. (2024) also show that technological development continues to influence service quality. Overall, these findings suggest that smart hospital systems can greatly improve healthcare performance, but only when technology, people, and systems are able to work together in a balanced and consistent way.

CONCLUSION

The findings show that the implementation of smart hospital systems has a clear influence on how orthopedic healthcare services are organized and delivered. The use of integrated digital systems allows hospitals to manage workflows in a more structured way, improve coordination between units, and support faster and more accurate decision-making. These changes are reflected in smoother service processes, reduced delays, and more consistent care across different stages of treatment. At the same time, the use of technologies such as artificial intelligence, robotics, and digital monitoring tools strengthens precision and supports continuity of care, especially in orthopedic services that require long-term treatment and rehabilitation. As a result, smart hospital systems contribute to creating a more responsive, efficient, and patient-centered healthcare environment.

Despite these advantages, several challenges still affect how effectively these systems can be implemented, including issues related to system integration, infrastructure readiness, cost, and user adaptation. These factors show that the success of smart hospital implementation depends not only on technology itself, but also on how well it is supported by organizational readiness and human resources. Future efforts should focus on strengthening system integration, improving user readiness, and ensuring that digital tools are applied in ways that truly support service delivery. Further research can explore more specific contexts within orthopedic care, including how different healthcare settings and patient characteristics influence the outcomes of digital transformation, in order to provide a deeper understanding of how smart hospital systems can be used more effectively.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest related to the conduct of the research, preparation, or publication of this article.

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All authors contributed to the preparation of this article. Mohamad Reza Hilmy, Raden Roro Sonya Dewi Wulandari, Ahdun Trigono, Erlina Puspitaloka Mahadewi and Fera Gusmi Nurba, was responsible for the conceptualization of the study, data collection and analysis, interpretation of the results, and manuscript preparation. The other authors contributed to the review, editing, and final approval of the manuscript.

GENERATIVE AI STATEMENT

The authors declare that no generative artificial intelligence was used in the preparation of this article.

REFERENCE

- Fucentese, S. F., & Koch, P. P. (2021). A novel augmented reality-based surgical guidance system for total knee arthroplasty. *Archives of Orthopaedic and Trauma Surgery*, 141, 2227–2233. <https://doi.org/10.1007/s00402-021-04204-4>
- Gani, R. A. (2024). Desain smart hospital dalam mendukung pelayanan kesehatan pada rumah sakit berbasis teknologi informasi. *Jurnal Global*, 11(1).
- Glinkowski, W. M., Spalińska, A., Wołk, A., & Wołk, K. (2026). Artificial intelligence in orthopaedics: Clinical performance, limitations, and translational readiness—A review. *Journal of Clinical Medicine*, 15(5), 1751. <https://doi.org/10.3390/jcm15051751>
- Halm-Pozniak, A., Lohmann, C. H., Zagra, L., Braun, B., Gordon, M., & Grimm, B. (2023). Best practice in digital orthopaedics. *EFORT Open Reviews*, 8(5), 283–290. <https://doi.org/10.1530/EOR-23-0081>
- Han, F., Huang, X., Wang, X., Chen, Y., Lu, C., Li, S., Lu, L., & Zhang, D.-W. (2025). Artificial intelligence in orthopedic surgery: Current applications, challenges, and future directions. *MedComm*, 6, e70260. <https://doi.org/10.1002/mco2.70260>
- Hasibuan, A. N. R., Harahap, J. W., Agustina, D., Hasibuan, S. R., Nurmairani, A., & Khairiah, M. (2024). Analisis strategi dalam optimalisasi pelayanan kesehatan melalui

- implementasi sistem informasi manajemen rumah sakit (SIMRS): Systematic literature review. *Jurnal Kolaboratif Sains*, 7(5), 1813–1821. <https://doi.org/10.56338/jks.v7i5.5075>
- Hilmy, M. R., Putranto, R. D., Mahadewi, E. P., Setiawan, I., & Shameela, A. (2025). Analysis of the relationship between digital transformation influenced by technology, artificial intelligence diagnosis, legal basis and challenges to health services in hospitals. *Syntax Literate: Jurnal Ilmiah Indonesia*, 10(12).
- Hilmy, M. R., Putranto, R. D., Mahadewi, E. P., Setiawan, I., & Shameela, A. (2026). Analisis integrasi sistem informasi rumah sakit dan elektronik rekam medik sebagai respon terhadap Permenkes Nomor 24 Tahun 2022. *Syntax Literate: Jurnal Ilmiah Indonesia*, 11(1).
- Hilmy, M. R., Shameela, A., & Mahadewi, E. P. (2026). Patient outcomes and service delivery differences in physiotherapy care: A systematic review comparing hospital-based and private practice models. *Healthyness Journal*, 6(1), 553–569.
- Hilmy Simanjuntak I. R. & Wahid K. R., R. (2026). *The effect of destination image and servicescape, with patient experience as an intervening variable, on revisit intention at the outpatient unit of RSUD Cempaka Putih*. *Syntax Literate: Indonesian Scientific Journal*, 11(2).
- Hu, R., Longo, U. G., Pittman, J., & Nazarian, A. (2025). Robotic innovations in orthopedics: A growing landscape, challenges, and implications for care. *Osteology*, 5(2), 13. <https://doi.org/10.3390/osteology5020013>
- Irwan, Yanto, E., Erlina, H. B., & Afdal, A. A. M. (2025). Implementasi artificial intelligence dalam administrasi rumah sakit untuk peningkatan efektivitas pelayanan: Studi literatur. *Journal of Health Quality Development*, 5(2), 40–49.
- Khodijah, E., Hilmy, M. R., & Nofiarni. (2025). Impact of psychological conditions and physical environment on hospitality services through patient experience. *International Journal of Health and Medicine*, 2(4). <https://doi.org/10.62951/ijhm.v2i4.522>
- Kim, S. J., Wang, T., Pelletier, M. H., & Walsh, W. R. (2022). SMART implantable devices for spinal implants: A systematic review on current and future trends. *Journal of Spine Surgery*, 8(1), 117–131. <https://doi.org/10.21037/jss-21-100>
- Koay, W. Z.-T., Chang, S.-W., Ahmad, R. E., & Kamarul, T. (2026). A scoping review of systematic reviews on artificial intelligence in orthopaedics. *Journal of Orthopaedic Surgery*, 34(1), 1–25. <https://doi.org/10.1177/10225536261424033>
- Mohammed, T. J., Xinying, C., Alnoor, A., Khaw, K. W., Albahri, A. S., Teoh, W. L., Chong, Z. L., & Saha, S. (2024). A systematic review of artificial intelligence in orthopaedic disease detection: A taxonomy for analysis and trustworthiness evaluation. *International Journal of Computational Intelligence Systems*, 17, 303. <https://doi.org/10.1007/s44196-024-00718-y>
- Noor, S. (2021). Smart hospital information technology master plan. *Jurnal Global*, 8(1).
- Ounasser, N., Rhanoui, M., Mikram, M., & El Asri, B. (2024). A systematic review on artificial intelligence in orthopedic surgery. *Revue d'Intelligence Artificielle*, 38(4), 1143–1157. <https://doi.org/10.18280/ria.380409>

- Prawasari, N., Rohendi, A., & Agung, I. W. P. (2024). Pengaruh persepsi kegunaan dan persepsi kemudahan terhadap kemauan tenaga kesehatan menggunakan SIMRS di Rumah Sakit Graha Husada Jepara. *PREPOTIF: Jurnal Kesehatan Masyarakat*, 8(3), 6866–6870.
- Priyadarshi, R., Ranjan, R., Sahana, B. C., Bhandari, A. K., & Kankanala, S. (2026). A comprehensive overview of smart healthcare technologies in revolutionizing modern rehabilitation practices. *Connection Science*, 38(1), 2612458.
- Purwayanto, E. A., Natasa, D. U., Triwibowo, D. N., & Suryani, R. (2025). Analisis implementasi sistem informasi medis pada fasilitas pelayanan kesehatan Indonesia: Literature review terhadap kendala dan solusi implementasi. *Jurnal Ilmu Komputer dan Teknologi (IKOMTI)*, 6(2), 98–102.
- Ramadhani, H., Issroviatiningrum, R., & Sari, D. W. P. (2025). Hubungan implementasi sistem informasi manajemen rumah sakit (SIMRS) dengan kinerja perawat. *Corona: Jurnal Ilmu Kesehatan Umum, Psikolog, Keperawatan dan Kebidanan*, 3(2), 60–74. <https://doi.org/10.61132/corona.v3i2.1207>
- Salazar Carrasco, L., Sánchez-Margallo, J. A., & Sánchez-Margallo, F. M. (2026). Orthopedic surgery assisted by mixed reality technology: Systematic review. *Frontiers in Surgery*, 13, 1770605. <https://doi.org/10.3389/fsurg.2026.1770605>
- Sihole, P. O., Lesmana, A. E., & Wasir, R. (2024). Strategi dan evaluasi sistem informasi kesehatan di Indonesia: Tinjauan literatur. *Jurnal Kesehatan Tambusai*, 5(2), 4811–4819.
- Suyitno, E., Febrianti, R., Hadiyani, S., Suryani, Y., & Aima, S. (2026). Transformasi digital dalam administrasi rumah sakit: Strategi peningkatan kualitas layanan dan pengambilan keputusan manajerial. *Jurnal Komputer, Informasi dan Teknologi*, 6(1), 1–17. <https://doi.org/10.53697/jkomitek.v6i1.39>
- Waris, C. D., & Hilmy, M. R. (2024). Analisis pemanfaatan rekam medis elektronik berdasarkan metode HOT-FIT di instalasi rawat jalan RSUD Kota Tanjungpinang. *Journal of Nursing and Public Health*, 12(2), 293–305.