



ANALYSIS OF PACS IMPLEMENTATION IN IMPROVING THE EFFICIENCY OF RADIOLOGY PROCESSES AT GRANDMED HOSPITAL LUBUK PAKAM

Marisi Sinaga *, Deli Theo, Ramadhani Syafitri Nasution

Fakultas Kesehatan Masyarakat, Institut Kesehatan Helvetia Medan

Jl. Kapten Sumarsono No.107, Kec. Sunggal, Kabupaten Deli Serdang, Sumatera Utara 20124, Indonesia

Email: msng.senior@gmail.com

Abstract

Radiology services in hospitals often face operational challenges, including delays in image access, prolonged reporting times, and dependence on conventional film, all of which affect service efficiency and user satisfaction. The implementation of a Picture Archiving and Communication System (PACS) is considered a digital solution to improve radiology service performance through electronic image storage, distribution, and visualization. This study aims to explore in depth the implementation process of PACS, its impact on the efficiency of radiology services, and the supporting and inhibiting factors influencing its success at the Radiology Installation of Grandmed Hospital Lubuk Pakam. This study employed a qualitative approach with a descriptive case study design. Data were collected through semi-structured interviews with 15 informants, including radiologists, inpatient and outpatient physicians, radiographers, nurses, and information technology staff. Data analysis focused on user experiences, system implementation dynamics, and perceptions of changes in radiology workflow. The results show that PACS at Grandmed Hospital Lubuk Pakam has been implemented gradually since 2015, supported by management policies and relatively adequate technological infrastructure. The system has proven to improve the efficiency of radiology services, particularly in accelerating image access, reducing reporting turnaround time (TAT), streamlining workflow, and enhancing interprofessional collaboration. Key supporting factors include strong hospital management commitment, human resource readiness, and the availability of basic infrastructure. Meanwhile, inhibiting factors include network disruptions and limited technical skills among some users. In conclusion, the implementation of PACS at Grandmed Hospital Lubuk Pakam is considered successful, demonstrating a positive impact on radiology efficiency and offering further development potential through infrastructure strengthening, continuous training, and integration with electronic medical record systems.

Keywords: Radiology Process Efficiency Supporting Factors, Inhibiting Factors, PACS Implementation

Introduction

Radiology services in hospitals frequently encounter operational challenges, including prolonged examination-to-reporting time, delayed image access for clinicians, and continued reliance on physical film media. These limitations disrupt workflow efficiency and negatively affect clinical decision-making speed as well as patient and healthcare provider satisfaction (Kemenkes RI, 2022; WHO, 2021). Inefficient radiology processes may lead to delays in diagnosis and treatment, ultimately compromising the quality of healthcare services.

The advancement of digital health technologies has introduced the Picture Archiving and Communication System (PACS) as a strategic solution to address these challenges. PACS is a digital

system designed to store, retrieve, distribute, and display medical images electronically, significantly reducing waiting times and improving accessibility of radiological data (European Society of Radiology, 2022). In recent years, the adoption of PACS has grown rapidly worldwide, driven by its ability to enhance workflow efficiency, improve productivity, enable simultaneous remote access to imaging data, support electronic archiving, and reduce operational costs, thereby improving overall patient care quality (Reiner & Krupinski, 2021).

Despite its advantages, the global implementation of PACS still faces several challenges. These include high initial investment and maintenance costs, limited infrastructure in developing settings, and a shortage of trained human resources. Interoperability remains a critical issue, as many healthcare facilities struggle to integrate PACS with existing systems such as Radiology Information Systems (RIS), Electronic Health Records (EHR), and cloud-based platforms (Alami et al., 2020; Keesara et al., 2020). Additionally, data security and regulatory compliance, particularly with frameworks such as HIPAA and GDPR, have become increasingly important as cloud-based PACS solutions gain traction. Emerging trends indicate a shift toward artificial intelligence (AI) integration and cloud computing, which promise improved efficiency but also introduce new challenges, including data migration complexity and vendor lock-in risks (Pérez-Sanpablo et al., 2025).

Empirical studies have demonstrated that PACS implementation can significantly reduce reporting turnaround time (TAT), in some cases from approximately 80 hours to 20 hours, while improving user productivity and interprofessional coordination (Alami et al., 2020). Furthermore, PACS facilitates better integration with hospital information systems, enabling streamlined workflows and improved accessibility to radiological images in clinical settings (European Society of Radiology, 2022).

In Indonesia, PACS implementation has been initiated in several major referral and private hospitals. Local studies report that PACS contributes to improved radiology workflow, faster reporting processes, enhanced data accessibility, and increased staff satisfaction. However, its adoption remains uneven across healthcare facilities. The success of PACS implementation in Indonesia largely depends on technological readiness, management support, and the adaptability of healthcare personnel to digital transformation (Indriyani & Putri, 2023).

The Indonesian government has reinforced digital transformation in healthcare through Regulation of the Minister of Health No. 24 of 2022 concerning Medical Records, which mandates the implementation of Electronic Medical Records (EMR). In this context, PACS plays a crucial role as a supporting system for digital radiology data management. The integration of PACS with EMR and hospital information systems is expected to enhance efficiency, reduce operational errors, and improve service quality, although challenges related to infrastructure, system integration, and human resource competencies remain (Kemenkes RI, 2022).

Radiology efficiency refers to the optimal balance between inputs such as workforce, time, capital, and technology and outputs, including the number of examinations, diagnostic quality, and service speed. Higher efficiency reflects better utilization of resources and improved quality of radiological services (Reiner & Krupinski, 2021). Previous studies support the positive impact of PACS on efficiency. Montazeri and Khajouei (2022) found that PACS significantly improves communication, user intention, and service quality ($p < 0.001$). Similarly, Indriyani and Putri (2023) reported improvements in time efficiency, data accuracy, accessibility, job satisfaction, and reduced film usage ($p < 0.05$). More recent evidence highlights the integration of artificial intelligence in PACS, which can enhance diagnostic accuracy up to 93.2% and reduce diagnostic time by up to 90% in critical conditions (Perez-Sanoablo et al., 2025).

Preliminary findings at Grandmed Hospital Lubuk Pakam indicate variability in staff understanding and technical skills related to PACS. Approximately 68% of respondents have never received formal training, 24% are self-taught, and only 8% possess certified training. Advanced

features, such as EMR integration and access control, are not yet optimally utilized. Key barriers include limited routine training, insufficient technical guidelines, and a lack of specialized human resources. A majority (85%) of respondents expressed the need for continuous training to keep pace with technological advancements.

Although Grandmed Hospital Lubuk Pakam offers comprehensive radiology services—including CT scan, X-ray, ultrasound, and radiotherapy—several inefficiencies persist. Film printing processes can take 2–3 days or longer, especially for imaging modalities with large datasets such as CT and MRI or during high patient volume periods. Additionally, simultaneous access for multiple clinicians and inter-hospital consultations, including teleradiology, remains limited. Physical film storage also creates challenges related to space constraints and data accumulation.

Furthermore, the hospital is currently planning to replace its PACS, which has been in operation for nearly a decade. The existing system has experienced performance degradation due to outdated hardware and software, limiting compatibility with newer radiological modalities. This situation may hinder workflow efficiency, image storage, and data distribution quality. The planned system upgrade aims to support integration with EMR, improve data security, and enhance overall radiology service performance.

Based on these issues, this study aims to analyze the implementation of PACS in improving the efficiency of radiology processes at Grandmed Hospital Lubuk Pakam. The findings are expected to provide empirical evidence and practical recommendations to optimize PACS utilization and improve healthcare service quality.

Methods

This study used a qualitative descriptive case study design to examine the implementation of the Picture Archiving and Communication System (PACS) in improving radiology process efficiency at Grandmed Hospital Lubuk Pakam, Indonesia. Data were collected from August 2025 to January 2026 (Sahir, 2021).

A purposive sampling technique was applied to select 15 informants, including radiologists, inpatient and outpatient physicians, radiographers, nurses, and IT staff who were directly involved in PACS utilization (Wada et al., 2024).

Data collection methods included semi-structured interviews, non-participant observations, and document review. Data validity was ensured through triangulation of sources and methods. Data were analyzed using thematic analysis, involving transcription, coding, categorization, and theme development (Syapitri et al., 2021; Sugiarto, 2022).

The results are presented narratively and supported by direct quotations to provide an in-depth understanding of PACS implementation and its impact on radiology service efficiency.

Result

PACS Implementation

The findings indicate that the implementation of the Picture Archiving and Communication System (PACS) at Grandmed Hospital Lubuk Pakam has been carried out gradually since 2015. The process began with a trial phase, followed by full implementation and continuous system utilization. Although not all informants were involved in the initial stages, the overall implementation was perceived as structured and sustainable.

The initial socialization and training processes were conducted; however, they were not evenly distributed across all professional groups. Some users reported relying on self-learning or informal guidance, which led to variations in user competence. Despite this, most informants acknowledged that the system became easier to use over time. As one radiographer stated, "At first it was difficult, but over time it became easier and faster."

In terms of infrastructure, the availability of servers, computers, and supporting devices was considered adequate to operate the system effectively. However, network instability was identified as a recurring technical issue that occasionally disrupted system performance. From a managerial perspective, strong support was evident through policy direction, system procurement, and maintenance. Although not all staff interacted directly with management, organizational commitment to PACS implementation was clearly recognized.

Overall, PACS implementation in the radiology unit is considered successful, with minor challenges related to network stability and unequal training distribution.

Radiology Efficiency

The implementation of PACS has significantly improved the efficiency of radiology services. One of the most notable impacts is the increased speed of image access. Clinicians can now view radiological images immediately without waiting for physical film processing. As expressed by one informant, "Now the results can be accessed directly without waiting for film."

In addition, PACS has contributed to a reduction in reporting turnaround time (TAT). Radiologists are able to interpret images more quickly after examinations are completed, although complex cases may still require additional time. A radiologist noted, "Reports are faster because we can read the images immediately after the examination."

Workflow within the radiology department has also become more efficient and organized. The elimination of film-related issues, such as lost or misplaced images, has streamlined service delivery. However, the dependency on digital systems means that technical disruptions, particularly network issues, can temporarily affect workflow continuity.

Furthermore, PACS has enhanced interprofessional collaboration. Multiple healthcare professionals can access the same images simultaneously, improving coordination between radiographers, radiologists, clinicians, and IT staff. This improvement has also contributed to increased user satisfaction, both among healthcare providers and patients, although system errors may still reduce satisfaction levels in certain situations.

Supporting and Inhibiting Factors

The implementation of PACS at Grandmed Hospital Lubuk Pakam is influenced by several supporting and inhibiting factors. The key supporting factors include strong management commitment, availability of infrastructure, and relatively prepared human resources. Management support plays a crucial role in ensuring system sustainability through policy-making, funding, and technical maintenance.

On the other hand, the main inhibiting factors are related to technical and human resource limitations. Network instability remains the most frequently reported issue, affecting system

accessibility and performance. In addition, some users still face challenges in operating the system due to limited technical skills and lack of formal training.

To address these challenges, several efforts have been implemented, including coordination with IT personnel, routine system maintenance, and infrastructure improvements. Informants also emphasized the need for continuous training programs and better system integration, particularly with electronic medical records (EMR).

Despite these challenges, most users expressed optimism regarding the future development of PACS, recognizing its importance in improving healthcare service quality and efficiency.

Human–PACS Interaction

The findings highlight that human factors play a central role in the successful implementation of PACS. Different professional groups interact with the system based on their respective roles. Radiographers are the primary users who operate the system daily, while radiologists utilize PACS for image interpretation and reporting. Clinicians access the system to support clinical decision-making, nurses use the information for patient care, and IT staff are responsible for system maintenance and troubleshooting.

The interaction between users and PACS is dynamic, involving processes of adaptation, learning, and eventual integration into routine practice. Initially, users may experience difficulties; however, over time, the system becomes an integral part of daily workflow.

This interaction can be understood across three dimensions: functional, cognitive, and emotional. Functionally, PACS improves efficiency and task performance. Cognitively, users must develop an understanding of the system to use it effectively. Emotionally, user attitudes and perceptions influence the level of system acceptance and utilization.

Overall, the relationship between humans and PACS is reciprocal and evolving. The success of PACS implementation is not solely determined by technological capability but also by user readiness, acceptance, and organizational support.

Tabel 1. Summary of Key Findings

Theme	Main Findings
PACS Implementation	Gradual implementation since 2015 with strong management support and adequate infrastructure
Radiology Efficiency	Faster image access, reduced reporting time, improved workflow and collaboration
Supporting Factors	Management commitment, infrastructure readiness, and human resources
Inhibiting Factors	Network instability and limited user technical skills
Human–PACS Interaction	Dynamic adaptation process involving functional, cognitive, and emotional dimensions

Discussion

The findings of this study demonstrate that the implementation of the Picture Archiving and Communication System (PACS) at Grandmed Hospital Lubuk Pakam has significantly improved the efficiency of radiology services. The gradual implementation process since 2015 reflects a structured approach to digital health adoption, which is consistent with studies highlighting that phased implementation enhances system sustainability and user acceptance (Aggrey et al., 2024).

The improvement in radiology efficiency is particularly evident in the acceleration of image access and the reduction of reporting turnaround time (TAT). This finding aligns with previous studies showing that digital imaging systems, including PACS, significantly improve workflow efficiency and reduce delays in clinical decision-making (Bharadwaj et al., 2024). Faster access to radiological images enables clinicians to initiate treatment more promptly, which is critical in clinical settings. However, this study also found that TAT may still be influenced by case complexity, indicating that technological systems cannot fully replace clinical judgment and variability.

Furthermore, workflow efficiency has improved as PACS eliminates the need for film-based processes, reducing issues such as lost or misplaced images. This is consistent with findings that digital transformation in radiology enhances operational efficiency and supports paperless healthcare systems (Aggrey et al., 2024). However, reliance on digital systems introduces new challenges, particularly related to infrastructure. Network instability identified in this study is in line with previous research indicating that technical limitations and system interoperability remain major barriers in PACS implementation (Lameira & Ferraz, 2024).

In terms of interprofessional collaboration, PACS allows multiple healthcare professionals to access radiological images simultaneously, thereby improving coordination among radiographers, radiologists, clinicians, and IT staff. This finding is supported by qualitative studies showing that PACS enhances communication and collaboration in clinical practice (McEntee et al., 2023). However, this study also confirms that digital systems do not replace the need for direct interpersonal communication, but rather complement it.

Organizational support emerged as a key success factor in this study. Strong management commitment, including policy support, funding, and system maintenance, plays a critical role in ensuring successful implementation. This is consistent with broader evidence on digital health transformation, which emphasizes the importance of leadership and organizational readiness (Aggrey et al., 2024). In addition, human resource readiness remains essential. Variations in user competence due to uneven training highlight the need for continuous capacity building to optimize system utilization.

The findings also emphasize the importance of human–technology interaction in PACS implementation. Users initially experienced difficulties but gradually adapted to the system, reflecting the process of technology acceptance. This is consistent with recent studies indicating that user experience and perceived usefulness strongly influence system adoption in healthcare settings (McEntee et al., 2023). Emotional responses, such as satisfaction and frustration, were also found to influence system utilization, particularly when technical issues arise.

Moreover, the study indicates strong potential for future development of PACS, particularly through integration with electronic medical records (EMR) and advanced technologies such as artificial intelligence (AI). Recent evidence suggests that AI integration within PACS can significantly enhance diagnostic accuracy and workflow efficiency, enabling faster and more precise clinical decisions (Pérez-Sanpablo et al., 2025). However, these advancements require improvements in infrastructure, interoperability, and data security.

Overall, this study confirms that PACS implementation not only improves radiology efficiency but also transforms workflow, professional collaboration, and organizational processes. Despite

challenges related to technical infrastructure and user training, PACS demonstrates strong potential to support ongoing digital transformation in healthcare services.

Conclusion

This study concludes that the implementation of the Picture Archiving and Communication System (PACS) at Grandmed Hospital Lubuk Pakam has significantly improved the efficiency of radiology services. The system has enhanced key aspects of radiology processes, including faster image access, reduced reporting turnaround time (TAT), improved workflow, and better interprofessional collaboration. These improvements contribute to increased satisfaction among healthcare providers and support more timely clinical decision-making.

The success of PACS implementation is largely influenced by strong management support, adequate infrastructure, and the readiness of human resources. However, several challenges remain, particularly related to network instability and variations in user technical competence due to uneven training. These barriers, although not critical, may affect the optimal utilization of the system.

Furthermore, the study highlights that the effectiveness of PACS is not solely determined by technological factors but also by the interaction between users and the system. User adaptation, experience, and acceptance play a crucial role in ensuring successful implementation.

References

- [1] Aggrey, R., Nketiah, L., Nunoo, G., & Cetin, E. (2024). Digital transformation in healthcare: A case study of PACS implementation. *International Journal for Multidisciplinary Research*, 6(6), 1–10.
- [2] Alami, H., Lehoux, P., Auclair, Y., de Guise, M., Gagnon, M. P., & Shaw, J. (2020). Artificial intelligence and health technology assessment: Anticipating a new level of complexity. *Journal of Medical Internet Research*, 22(7), e17707. <https://doi.org/10.2196/17707>
- [3] Bharadwaj, P., Berger, M., Blumer, S. L., & Lobig, F. (2024). Selecting the best radiology workflow efficiency applications. *Journal of Imaging Informatics in Medicine*, 37, 2740–2751. <https://doi.org/10.1007/s10278-024-01146-2>European Society of Radiology. (2022). ESR paper on the digital transformation of radiology. *Insights into Imaging*, 13(1), 1–10. <https://doi.org/10.1186/s13244-022-01200-5>
- [4] Indriyani, D., & Putri, D. A. (2023). The impact of PACS implementation on radiology service efficiency in Indonesian hospitals. *Jurnal Manajemen Pelayanan Kesehatan*, 26(2), 85–94.
- [5] Kementerian Kesehatan Republik Indonesia. (2022). *Peraturan Menteri Kesehatan Republik Indonesia Nomor 24 Tahun 2022 tentang Rekam Medis*. Jakarta: Kemenkes RI.
- [6] Keesara, S., Jonas, A., & Schulman, K. (2020). Covid-19 and health care's digital revolution. *New England Journal of Medicine*, 382(23), e82. <https://doi.org/10.1056/NEJMp2005835>
- [7] Lameira, D., & Ferraz, F. (2024). Interoperability challenges in Picture Archiving and Communication Systems (PACS): A review. *Health Informatics Journal*, 30(1), 1–12.
- [8] McEntee, M. F., Evanoff, M. G., & colleagues. (2023). Clinician experiences in accessing medical imaging: A qualitative study. *Journal of Imaging Informatics in Medicine*, 36(4), 1205–1215.

- [9] Montazeri, M., & Khajouei, R. (2022). Evaluation of PACS impact on radiology workflow and user satisfaction. *BMC Medical Informatics and Decision Making*, 22(1), 1–10. <https://doi.org/10.1186/s12911-022-01845-2>
- [10] Pérez-Sanpablo, A. I., et al. (2025). Artificial intelligence integration in PACS: Enhancing diagnostic accuracy and workflow efficiency. *Radiology: Artificial Intelligence*, 7(1), e230245.
- [11] Reiner, B. I., & Krupinski, E. A. (2021). The evolving role of technology in radiology workflow optimization. *Journal of Digital Imaging*, 34(2), 215–223. <https://doi.org/10.1007/s10278-020-00420-1>
- [12] Sahir, S. H. (2021). *Metodologi penelitian*. Yogyakarta: Penerbit KBM Indonesia.
- [13] Sugiarto. (2022). *Metode penelitian kualitatif dalam bidang kesehatan*. Jakarta: Prenada Media.
- [14] Syapitri, H., Siregar, L. M., & Sinaga, J. (2021). *Metode penelitian kesehatan*. Medan: Yayasan Kita Menulis.
- [15] Wada, Y., et al. (2024). Qualitative sampling strategies in healthcare research. *BMC Health Services Research*, 24(1), 1–9
- [16] World Health Organization. (2021). *Global strategy on digital health 2020–2025*. Geneva: WHO.