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The Impact of Implementing a Picture Archiving and Communication System (PACS) on Minimum Service Standards in the Field of Radiology

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KEYWORDS

Picture Archiving and Communication System (PACS), Minimum Service Standards, Radiology.

ABSTRACT

The use of Picture Archiving and Communication System (PACS) has become an important step to increase the efficiency of radiology services. With PACS, fast access and flexibility in accessing patient medical images has had a major impact on reducing waiting times for radiology examination results. The aim of this research is to determine the waiting time for radiology services at the UPTD Embung Fatimah Regional Hospital, Batam City after implementing PACS. The research uses a mix-method method, namely research that combines quantitative and qualitative methods. Quantitative method by collecting service time data. Qualitative method by conducting in-depth interviews (in-depth interviews) and focus group discussions (FGD) to obtain information on perceptions from service implementers and users, then researchers will assess the impact of PACS on Minimum Service Standards (SPM) in the field of radiology at UPTD RSUD Embung Fatimah Batam city.The results of this research are that the use of PACS has significantly reduced radiology service time at the UPTD Embung Fatimah Regional Hospital, Batam City. There was a significant decrease in service time for outpatient services previously from 101.09 minutes to 62 minutes or 35.3%, for inpatient services from 108.26 minutes to 65.6 minutes or 41.04% and for CITO patients from 104.27 minutes to 60.5 minutes or 41.06% after application of PACS. The views of radiologists and radiographers regarding the differences in the quality of radiology services before and after using the PACS system show that there are better changes in the efficiency and quality of radiology services in hospitals. Stakeholder perceptions related to the speed of radiology service time after using the PACS system through various factors are considered to have a positive impact. Implementation of PACS clearly shows the potential for improving the efficiency, speed, and overall quality of radiology services. There was a significant reduction in waiting time for radiology examination services at the UPTD Embung Fatimah Hospital, Batam City after the implementation of PACS, which can provide an alternative in changing workflow and efficiency of radiology services.

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INTRODUCTION

Healthcare services and hospitals are the cornerstone of providing effective medical care, providing patients with important diagnostic and treatment solutions (AL GHIFARI, 2019; World Health Organization (WHO), 2022). In the context of health services, a smooth diagnostic process, well-structured workflow, and consistent service quality are very important (Indriani, Larasati, & Lestari, 2015). In Indonesia, health facilities are bound by a strict regulatory framework that outlines operational standards that must be upheld (Siringoringo, Hendrawati, & Suharto, 2017). These regulations are designed to ensure patient safety, guarantee the provision of high-quality care, and comply with

internationally recognized standards, thereby fostering trust in the healthcare system (Hadiyati, Sekarwana, Sunjaya, & Setiawati, 2017; Utami & Alawiya, 2018).

Decree of the Minister of Health of the Republic of Indonesia Number 129/Menkes/SK/II/2008 which regulates Minimum Service Standards (SPM) for Hospitals, has an important role in improving health services in hospitals in Indonesia (Ministry of Health, 2008a). This decision specifically maps out guidelines and guidelines for hospitals to provide quality and standardized health services (Sumardjoko & Akhmadi, 2020). By referring to these standards, hospitals are expected to be able to optimize existing facilities, medical personnel, and infrastructure to provide the best service to patients (Kuzairi, Yuswadi, Budiharjo, & Patriadi, 2017). The implementation of this standard also supports efforts to improve health services as a whole, because it has a clear and measurable framework, one of which is the waiting time for thorax photo services within the Minimum Service Standards, namely 3 hours (Astuti, Arso, & Wigati, 2015).

Through the Minister of Health's Decree, health services in hospitals have become more focused and transparent. This standard-setting provides a reference regarding facilities, human resources, facilities, and infrastructure, as well as other aspects that must be present in hospital operations. Not only does it provide certainty for patients regarding the expected quality of service, but it also encourages hospitals to innovate and continue to strive to improve services so that they comply with established standards.

One area that continues to improve patient services is radiology, radiology services play an important position in a series of patient care, enabling correct diagnosis and appropriate treatment planning (Aryati, 2020). In a hospital service system, the radiology installation is a supporting field that facilitates imaging which is important for making medical decisions (Sayuti, Imbaruddin, & Rusli, 2015). Ensuring the quality and suitability of radiology services is the basic goal of optimizing patient services and continuing to strive to simplify workflow while still providing optimal results (Suharyanta & A'yunin, 1978). One effort to improve radiology services in this digital era is to use Picture Archiving and Communication System (PACS).

UPTD RSUD Embung Fatimah in Batam City has a strong focus on improving the quality of radiology services. Determination of Minimum Service Standards (SPM) for Radiology at UPTD RSUD refers to the guidelines set out in the Decree of the Minister of Health of the Republic of Indonesia Number 129/Menkes/SK/II/2008, namely 3 hours. This standard has an important role in ensuring the quality of services in hospitals, including the length of waiting time for radiology services (Rahmaddian, Semiarty, & Lita, 2019). Although the length of waiting time for expertise by radiologists is not specifically explained in the standards, the waiting time for radiological examinations, especially chest x-rays, is regulated not to exceed 3 hours by the Minimum Service Standards (SPM) (Ministry of Health, 2008b).

In the development of medical technology, the use of Picture Archiving and Communication Systems (PACS) has become an important step in improving the efficiency of radiology services. Before the implementation of PACS, important factors in radiology service quality standards were diagnostic accuracy and efficient communication of findings to stakeholders who needed them (Setyawan & Supriatna, 2016). With the existence of PACS, fast access and flexibility in accessing patient medical images has had a major impact on reducing the waiting time for radiology examination results (Alalawi, Eid, & Albarrak, 2016). PACS allows radiologists to access medical images remotely and allows timely intervention and effective actions (Suandari, Juliantara, & Rusmana, 2020).

The implementation of Minimum Service Standards (SPM) for radiology which refers to the Decree of the Minister of Health which has been used so far is 3 hours, with the adoption of PACS at

UPTD Embung Fatimah Regional Hospital, Batam City, it has positively optimized the radiology service process. The waiting time for radiology services at UPTD Embung Fatimah Regional Hospital, Batam City in practice tends to be below the Minimum Service Standard (SPM), although sometimes it is several times above the Minimum Service Standard (SPM), so it is necessary to measure service time and adjust the Minimum Service Standard (SPM) indicators.) radiology, especially in terms of waiting time for radiology services. This adjustment is due to the advantages of PACS and the mission of UPTD Embung Fatimah Hospital, Batam City, which continues to strive to improve health services in the community, one of which is through radiology services.

Based on the background, it is necessary to prepare Minimum Service Standards (SPM) for radiology services at UPTD Embung Fatimah Regional Hospital, Batam City based on the speed of waiting time for radiology services. For this reason, research was conducted with the title "Analysis of the Impact of Implementing a Picture Archiving and Communication System on Minimum Service Standards (SPM) in the Field of Radiology".

METHOD

This research uses a mixed-method approach, which combines quantitative and qualitative methods. Quantitative methods were used to collect radiology service time data before and after the implementation of the Picture Archiving and Communication System (PACS) at the UPTD Embung Fatimah Regional Hospital, Batam City. This quantitative data will help in measuring differences in the efficiency of radiology services numerically. Meanwhile, qualitative methods were carried out through in-depth interviews and Focus Group Discussions (FGD) with various related parties, such as radiologists, radiographers, and other officers, to explore their perceptions, experiences, and views on the implementation of PACS and its impact on radiology services.

A complete description of the research variables includes the variable scale, method of measurement, type of variable size, variable units, and range of variable values which are explained in the following table:

The research subject consists of two parts. Quantitative subjects included all officers and patients at UPTD Embung Fatimah Regional Hospital, Batam City, while qualitative subjects were divided into informants from the service implementing group and informants from the user group. Quantitative data collection was carried out through medical records or hospital information systems, while qualitative data was collected through in-depth interviews and FGDs.

The research procedure included collecting quantitative and qualitative data separately. Quantitative data collection was carried out by collecting data on waiting times for radiology services before and after PACS implementation, while qualitative data collection was carried out through in-depth interviews and FGDs. The research tools used included interview sheets, FGD guides, and data on the duration of radiological examinations.

Data analysis techniques include statistical analysis for quantitative data using the SPSS 21.0 for Windows application, with the data testing criteria being said to be significant if there is a difference between before and after using PACS. Meanwhile, for qualitative data, descriptive analysis was carried out in the form of tables and thematic analysis to identify important patterns and themes that emerged in the views and experiences of stakeholders regarding the implementation of PACS and its impact on the efficiency of radiology examination services. The integration of the results from these two analysis methods was carried out to provide a more complete understanding of the impact of PACS implementation on radiology services and its implications for service standards at UPTD Embung Fatimah Regional Hospital, Batam City.

RESULTS AND DISCUSSION

Radiology Service Time at UPTD Embung Fatimah Regional Hospital, Batam City After Implementing PACS

Determining the time of radiology services at the UPTD Embung Fatimah Regional Hospital, Batam City was carried out through a comparison of pre and post-implementation of PACS, collecting data on radiology examination service times one month pre-implementation of PACS, totaling 633 patients and post-implementation of PACS, totaling 654 patients. Data on examination times for radiology services is separated based on examination qualifications, namely outpatients or polyclinics, inpatients and CITO patients.

Data Normality Test

The normality test is a test carried out with the aim of determining whether the data collected on each variable is normally distributed or not. This test uses the methodKolmogorov-Smirnov because the number of samples in this study was more than 50 samples.

Table 2. Data normality test for outpatients, inpatients and CITO

Variable	*p-value
Pre outpatient	0,200
Post outpatient	0,200
Pre-hospitalization	0,00
Post hospitalization	0,008
I quote	0,02
Soon after	0,18

* Kolmogorov-Smirnov

Table 2 shows the results of the normality test that value p-value <0.05 so that the data is not normally distributed, the test that will be carried out is the test non parametric namely by using a testMan Whitney and if the data is normally distributed then the test that will be carried out is the test parametric namely by using a test unpaired t-test.

Radiology Outpatient Data pre and post-implementation of PACS

Data on outpatient radiology service time for one month before implementing PACS totaling 67 patients and after implementing PACS totaling 67 patients were then analyzed to obtain information that is useful in managing time and resources in hospitals. This time measurement was carried out with the number of outpatients, namely one month before and after the implementation of PACS.

Table 3. Outpatient data on PACS implementation

	Mean	SD	*p-value
Pre PACS Outpatient	100.97	8.098	0,000
Post PACS Outpatient	65.61	15.091	

* Unpaired t-test

Table 3 shows that there are differences in waiting times for outpatients a month before and after implementing PACS. The average time before using PACS was 101.09 (minutes) while after implementing PACS there was a decrease of 65.61 (minutes) or a decrease in time of up to 35.3%. Based on test unpaired t-test shows the value p-value 0.000 is less than 0.005 which can be interpreted

as meaning that there is a difference in the waiting time for outpatient expertise results after implementing PACS.

Radiology Inpatient Data pre and post-implementation of PACS

Data on inpatient radiology service time for one month before implementing PACS totaling 413 patients and after implementing PACS totaling 439 patients, has been analyzed to obtain information that is useful in managing time and resources in hospitals. This time measurement was carried out by the number of inpatients, namely one month before and after the implementation of PACS.

Table 4. Inpatient data on PACS implementation

	Mean	SD	*p-value
Pre PACS Inpatient	108.26	8.018	0,000
Post PACS Rawat Inap	61.90	13.077	

*Man whitney

Table 4 shows that there is a difference in the waiting time experienced by inpatients in the month before and after implementing PACS. The average time before using PACS was 108.26 (minutes) while after implementing PACS there was a decrease of 61.90 (minutes) or a decrease in time of up to 41.04%. Based on the test Man whitney shows that the value 0.000 is less than 0.005 which can be interpreted as meaning that there is a difference in the waiting time for expert results for inpatients after implementing PACS.

Cito Radiology Patient Data pre and post-implementation of PACS

Data on radiology service time for Cito patients for one month before the implementation of PACS amounted to 153 people and after implementing PACS there were 148 people. Research data has been analyzed to obtain information that is useful in managing time and resources in hospitals. This time measurement was carried out with the number of CITO patients, namely one month before and after the implementation of PACS.

Table 5. Cito patient data on PACS implementation

	Mean	SD	*p-value
Pre PACS Cito Patients	104.26	7.230	0,000
Post PACS Cito Patients	60.52	11.919	

*Man whitney

Table 5 shows that there is a difference in the waiting time received by Cito patients in the month before and after implementing PACS. The average time before using PACS was 104.26 (minutes) while after implementing PACS there was a decrease of 60.52 (minutes) or a decrease in time of up to 41.6%. Based on testMan whitney shows that valuep-value 0.000 is less than 0.005 which can be interpreted as meaning that there is a difference in the waiting time for CITO patient expertise results after implementing PACS.

Perceptions of Radiology Specialist Doctors and Radiographers seen from the Quality of Radiology Examination Services After Using the PACS System

The collection of information to determine the perception of radiologists and radiographers about the quality of radiological examination services after using the PACS system which was carried out

using in-depth interview methods(indepth interview) to a radiology specialist doctor and five radiographers, from the interview the following results were obtained:

Table 6. Flow of expertise and radiology service results after using PACS

Source	Answer
Radiology Specialist Doctor	"After implementing PACS, radiological examinations have become more efficient both in terms of the overall speed of radiology services because reading time has been reduced quite significantly."
Radiographer 1	"After implementing PACS, there are several steps that have become more effective, thereby reducing the overall radiology examination process or time, starting from the print out process before reading, the process of sending photos to radiologists, as well as archiving photos, which has become much more effective."
Radiographers 2	“After implementing PACS, the flow of radiology examination results experienced significant changes. Radiology images are now available in digital format, which eliminates the need for printing physical films. This means radiologists can quickly access patient images and immediately begin diagnosis without waiting for physical delivery of the film.”
Radiographers 3	“The flow of radiology examination results becomes more efficient after using PACS. With this system, radiographers upload radiology images to the system, and radiologists can access them electronically. This saves time previously spent on physical delivery of images and allows for quicker diagnosis.”
Radiographers 4	“In the context of PACS, the flow of radiology examination results has changed to become more computerized. Radiology images are available in seconds via the software, which makes the diagnosis process more efficient. Radiographers no longer have to physically print films or deliver photos to radiologists.”
Radiographers 5	“After implementing PACS, the flow of radiology examination results experienced positive changes. The process of printing and physically delivering radiology images has been replaced by digital systems. Radiographers can upload images directly, ensuring radiologists can see them quickly, resulting in faster and more efficient diagnoses.”

Based on the results of the perceptions of the six respondents, through in-depth interview methods it can be concluded that the use of PACS (Picture Archiving and Communication System) in radiology services in hospitals has resulted in a significant increase in time. In terms of overall speed of radiology services, there have been improvements which include reducing reading time by specialist radiologists and increasing effectiveness in various steps such as the photo printing process, sending photos to radiologists, and archiving photos. The overall use of PACS has brought great benefits in optimizing radiology examination times and processes, ultimately contributing to more efficient and quality patient care. Through the first question, it can be seen that the implementation of PACS makes a positive contribution to improving quality.

Table 7. Ease of carrying out expertise and inspections after using PACS

Source	Answer
Radiology Specialist Doctor	"Overall, it makes the series of inspections very easy, especially in terms of accessibility when reading because the workstation monitor and reading monitor are separate but the image quality remains the same."
Radiographer 1	“Overall, PACS significantly simplifies radiology examinations by providing fast access, sharing capabilities, and software that supports better patient diagnosis and care processes.”
Radiographer 2	“Yes, the use of PACS makes it significantly easier to carry out radiological examinations. With instant access to radiology images and a wide range of software features, radiographers can easily analyze images, make more accurate assessments and support patient care more effectively.”
Radiographer 3	“PACS really makes radiological examinations easier. With the ability to quickly access patient images and share data with the rest of the medical team, the examination process becomes more collaborative and efficient, ultimately benefiting the patient.”
Radiographer 4	“With PACS, carrying out radiological examinations becomes much more comfortable. Radiographers no longer have to print physical films or face delays in image delivery. All images are available in digital format, which makes diagnosis faster and more accurate.”
Radiographer 5	“Yes, PACS really makes radiological examinations easier. Radiographers can access patient images instantly, and integrated software allows them to perform more in-depth analysis. In addition, collaboration with radiologists and other specialists becomes easier by sharing digital data.”

Based on the results of in-depth interviews with the six respondents, it can be concluded that the use of PACS (Picture Archiving and Communication System) in radiology services in hospitals as a whole greatly facilitates and increases the effectiveness of radiological examinations. This includes increasing accessibility when reading by radiologists, with separate workstation monitors and reading monitors but with the same image quality. In addition, PACS provides benefits in the form of fast access, sharing capabilities, and software that supports better diagnosis and patient care processes for radiographers. Thus, the implementation of PACS increases the overall efficiency and quality of radiology services in hospitals.

Table 8. Data accessibility after using PACS

Source	Answer
Radiology Specialist Doctor	"Accessing data is becoming easier and better. Previously, with the manual photo archiving storage system, we sometimes had difficulty finding old photos for comparison. With the PACS system, many things have become easier and more helpful."

Radiographer 1	"With PACS, radiology images are stored in digital format that can be accessed quickly via a computer or other device. This eliminates the delays associated with looking for physical films and allows radiographers to immediately view patient images."
Radiographer 2	"After using PACS, the data access process becomes more efficient. Radiology images are stored in digital format that can be accessed quickly via a computer or other device. This eliminates the delays associated with searching for physical films and allows radiographers to immediately view patient images."
Radiographer 3	"With PACS, data access becomes faster and more practical. All radiology images are available in a centralized digital system. Radiographers and radiologists can easily access patient images through an easy-to-use interface, saving time previously spent searching for physical films."
Radiographer 4	"The process of accessing data after using PACS becomes more modern and efficient. Radiology images can be retrieved quickly via PACS software, without the need to search for physical films in various storage locations. This allows medical teams to respond more quickly to patient needs."
Radiographer 5	"With PACS, data access becomes more structured and efficient. All radiology images are stored in a system that can be easily accessed by authorized members of the medical team. This reduces the risk of loss or error in image capture and ensures that patient data is available quickly when needed."

Based on the perceptions of the six respondents, through in-depth interview methods it can be concluded that the implementation of PACS(Picture Archiving and Communication System) has resulted in positive improvements in accessing and storing radiology data in hospitals. Previously, manual storage and archiving systems often resulted in difficulties in finding old photos for comparison, whereas with PACS, radiology images are stored in a digital format that can be quickly accessed via a computer or other device. This eliminates the delays associated with searching for physical films and allows radiologists and radiographers to easily access and view patient images, thereby improving the overall efficiency and quality of radiology services, not only for radiologists and radiographers but also for other parties involved. interested parties, such as doctors sending polyclinics, or doctors on duty in the ER who generally need fast access to images.

Table 9. Ease of data access after using PACS

Source	Answer
Radiology Specialist Doctor	"Data access after using PACS is very easy considering that now I can carry out interpretation from almost any location as long as the device and network support it."
Radiographer 1	"By using PACS, the data access process becomes faster, more efficient and structured, which ultimately increases the efficiency of treatment and diagnostic capabilities by medical personnel."

Radiographer 2	"Yes, the use of PACS makes it significantly easier to access data. All radiology images are available in digital format that can be accessed quickly via computer devices. This eliminates the delays associated with searching for physical films and ensures that patient data is always easily available."
Radiographer 3	"With PACS, accessing data becomes much easier. Radiographers and radiology physicians can quickly search and view patient images through the digital system, saving time previously spent searching the archives for physical radiology films."
Radiographer 4	"Yes, PACS makes it easier to access radiology data. The images are stored in a structured digital database, allowing radiographers and radiologists to access them quickly without having to search for films manually. This increases efficiency in patient management."
Radiographer 5	"PACS effectively increases the ease of accessing data. By using PACS software, medical team members can easily search and view patient radiology images from a computer or other device. This ensures that data is always available when needed, supporting faster diagnosis and more efficient treatment."

Based on the results of in-depth interviews with the six respondents, through the in-depth interview method it can be concluded that the use of PACS (Picture Archiving and Communication System) has resulted in positive improvements in radiology medical data access in hospitals. Radiology specialists revealed that after using PACS, data access became very easy, allowing them to carry out interpretations from almost any location as long as the device and network supported it. Meanwhile, radiographers highlighted that PACS increases the efficiency of data access, making the process faster, more efficient and structured. This ultimately increases the efficiency of patient treatment and diagnostic capabilities by medical personnel. Thus, PACS has brought great benefits in terms of radiology data access and improving the quality of service in hospitals.

Table 10. Timeliness of examination and reading of PACS radiology results

Source	Answer
Radiology Specialist Doctor	"After implementing PACS, reading photos is faster than before using PACS, the inspection results are also more precise and accurate because reading can use DICOM files more accurately than print outs."
Radiographer 1	"PACS has helped improve timeliness, speed, accuracy and accuracy in radiological examinations in hospitals, because the system is digital, no longer searches are carried out manually, the patient registration system has also been integrated so that in its application, from patient examination to image reading to results the readings are handed over to the patient, the whole process becomes more effective and faster."
Radiographer 2	"PACS has helped improve timeliness, speed, accuracy and accuracy in radiological examinations in hospitals, because the system is digital, no longer searches are carried out manually, the

	patient registration system has also been integrated so that in its application, from patient examination to image reading to results the readings are handed over to the patient, the whole process becomes more effective and faster."
Radiographer 3	"PACS has helped improve timeliness, speed, accuracy and accuracy in radiological examinations in hospitals, because the system is digital, no longer searches are carried out manually, the patient registration system has also been integrated so that in its application, from patient examination to image reading to results the readings are handed over to the patient, the whole process becomes more effective and faster."
Radiographer 4	"PACS has helped improve timeliness, speed, accuracy and accuracy in radiological examinations in hospitals, because the system is digital, no longer searches are carried out manually, the patient registration system has also been integrated so that in its application, from patient examination to image reading to results the readings are handed over to the patient, the whole process becomes more effective and faster."
Radiographer 5	"PACS has helped improve timeliness, speed, accuracy and accuracy in radiological examinations in hospitals, because the system is digital, no longer searches are carried out manually, the patient registration system has also been integrated so that in its application, from patient examination to image reading to results the readings are handed over to the patient, the whole process becomes more effective and faster."

The conclusion from these two answers is that the use of PACS (Picture Archiving and Communication System) has resulted in significant improvements in radiology services in hospitals. The radiology specialist emphasized that after using PACS, reading photos became faster, examination results were more precise and accurate because this system allows reading using DICOM files which are more accurate than print outs. Meanwhile, radiographers highlighted that PACS has helped improve timeliness, speed, accuracy and accuracy in radiology examinations in hospitals. The process of examining patients from reading images to sending results to patients has become more effective and faster because this system has become digital, eliminating manual searches and integrating the patient registration system. Thus, PACS has brought great benefits in terms of efficiency and accuracy in radiology services in hospitals.

Stakeholder Perceptions Regarding Analysis of the Speed of Radiology Service Time in Determining Minimum Service Standards (SPM) for Radiology After Using the PACS System

Perceptionstakeholder (director, deputy director, medical support management, JKN unit head, radiology specialist, and emergency room doctor/sender) related to the speed of radiology service time in determining minimum service standards (SPM) for radiology at UPTD Embung Fatimah Regional Hospital, Batam City, explored through a processFocus Group Discussion (FGD), this is a data collection process by gathering the Director, Deputy Director of the Support Section, Head of the Medical Support Section, Head of the JKN Section, two specialist doctors, and two doctors on duty at the ER, in a meeting room and then asked questions for discussion. using the FGD guide. Of the eight

questions for each question, all participants were invited to answer, then a discussion was held together to reach a conclusion on one answer for each question.

Table 11. Flow of radiology services after using PACS

Source	Answer
FGD Team (8 People)	a. Sending Doctor: The sending doctor prescribes radiology examinations based on the patient's needs. These requests can be entered into the PACS system as specific radiology examination requests. b. Carrying out the Examination: The radiographer carries out a radiological examination according to the request of the sending doctor. The resulting radiological images are stored in PACS. c. Radiology Expertise: A radiology specialist examines radiology images via PACS. They provide a diagnosis and specialist review of the results. d. Return to the sending doctor: The results of the radiology expertise can then be shared via the PACS system with the sending doctor. The sending doctor can access the results to determine further treatment or communicate with the patient.

Based on the discussion of the FGD team above, the flow of radiology services using PACS begins with the sending doctor who prescribes a radiology examination, then continues with the radiographer then carries out the examination and saves the results in PACS, followed by a specialist radiology doctor carrying out expertise on radiological images via PACS, then the results This expertise can be shared back with the sending doctor via the PACS system, enabling better collaboration and communication in determining patient care. Thus, PACS facilitates an efficient and integrative workflow in radiology services in hospitals.

Table 12. Ease of flow of radiology services

Source	Answer
FGD Team (8 People)	"Yes, using PACS makes it very easy to request photos, radiological examinations, and get expert results. Inspection requests and results can be logged, accessed and shared digitally via PACS, saving the time and effort previously required to print and mail physical results."

Based on the results of the FGD on the questions above, information was obtained that the use of PACS (Picture Archiving and Communication System) has facilitated the process of requesting photos, radiological examinations, and obtaining expert results. This system enables digital recording, access, and sharing of data, reducing the need to print and send physical results, which in turn saves time and effort in improving radiology services. This information shows that PACS provides great efficiency to work flow and radiology services in hospitals.

Table 13. Data access process after using PACS

Source	Answer

FGD Team (8 People)	"The process of accessing data via PACS involves searching patient data, accessing radiology images, then reviewing by radiologists, accessing expertise results and viewing images for relevant stakeholders becomes easier, this can be done quickly through the integrated PACS system."

Based on the results of the discussion from the FGD Team, it can be concluded that the answer to the third question is, the use of PACS (Picture Archiving and Communication System) has simplified and accelerated the process of accessing radiology data. This process involves searching patient data, access to radiology images, review by a radiology doctor, access to expertise results, and the ability to view radiology images for relevant stakeholders. All of these steps can be done quickly and efficiently through an integrated PACS system. Thus, PACS allows easier and faster data access for various parties involved in radiology services in hospitals.

Table 14. Ease of data access after using PACS

Source	Answer
FGD Team (8 People)	“Yes, PACS increases the ease of accessing patient data and radiology images. "Data can be accessed from various locations in the hospital with an internet connection, enabling faster and more efficient access, both for the sending doctor, reviewing and searching for data again by the radiographer, as well as reviewing and reading images by the radiologist to become more efficient and faster."

The results of the discussion from the FGD Team for the fourth question, namely, the use of PACS (Picture Archiving and Communication System) has significantly improved the ease of accessing patient data and radiology images in hospitals. Data can be accessed from various locations in the hospital with an internet connection, allowing faster and more efficient access. This applies to both the sending doctor who makes the request, the radiographer who reviews and re-searches the data, and the radiologist who reviews and reads the images. Overall, PACS has increased efficiency in radiology services in hospitals.

Table 15. Timeliness of radiology services with PACS

Source	Answer
FGD Team	“With PACS, radiology services become faster, more precise and accurate. Quick access to radiology images, reduced risk of errors, and better coordination of the medical team contribute to increased timeliness and accuracy in patient diagnosis and treatment.”

Based on the results of the discussion from the FGD Team, it can be concluded that the answer to the fifth question is, the use of PACS (Picture Archiving and Communication System) has significantly improved radiology services in hospitals. With PACS, radiology services become faster, more precise and accurate. Quick access to radiology images, reduced risk of errors, and better coordination between medical teams contribute to increased timeliness and accuracy in patient

diagnosis and treatment. This shows that PACS brings great benefits in improving the quality of medical services through more efficient and accurate radiology processes.

Table 16. Data access after using PACS

Source	Answer
FGD Team	"Yes, data stored in PACS can be accessed from various locations with a secure internet connection and according to permission. This allows wider access by medical teams who need this information, and allows radiologists to interpret images without being in a hospital environment or in a radiology room."

The conclusion of the discussion on the sixth question by the FGD Team was that the use of PACS (Picture Archiving and Communication System) has resulted in significant improvements in the accessibility of radiology data. Data stored in PACS can be accessed from various locations with a secure and permission-compliant internet connection. This not only facilitates wider access for medical teams who need this information, but also allows radiologists to interpret radiological images without having to be in the hospital environment or in the radiology room. Thus, PACS provides flexibility in terms of radiology data access, which contributes to improving the quality of medical services and the mobility of medical personnel.

Table 17. Length of time for the radiology service process from start to finish after using PACS

Source	Answer
FGD Team	"After using PACS for radiology expertise, the time required can be shorter. For example, for Thorax Photos, expert results can be available within a few hours or even faster, depending on the priority of the case and the availability of a specialist radiologist."

Based on the results of the FGD Team's discussion in answering the seventh question, the following answer was obtained, the use of PACS (Picture Archiving and Communication System), the time required for radiology services can vary and tends to be slower. For example, in the case of a Thorax X-ray, the time required may be several hours to a day, depending on various factors such as the volume of work and manual processes applied. However, with the implementation of PACS, the overall radiology service process becomes faster and more efficient, reducing the time needed to access, evaluate, and convey results to patients. Thus, PACS contributes to increasing efficiency in radiology services in hospitals.

Table 18. Adjustments for Radiology SPM after PACS use

Source	Answer
FGD Team	"By considering factors such as changes in service processes, increased efficiency, integration with other systems, data security, increased quality of service, staff training needs, adjustments to the Radiology SPM after using PACS can be an important step to ensure that radiology services remain in accordance with standards highest, efficient and safe for patients. This adjustment process usually involves

	collaboration between the radiology team, hospital management, and other related parties to ensure that the new SPM reflects the current conditions post PACS implementation."

After conducting discussions by the FGD Team, the answer to the last question was obtained, namely, adjusting the Radiology SPM after using PACS is a very important step to ensure that radiology services remain in accordance with the highest standards, are efficient and safe for patients. This adjustment process includes changes in service processes, increased efficiency, integration with other systems, increased data security, and increased service quality. In addition, this adjustment also takes into account the training needs of radiology staff so that they can operate the PACS properly.

Collaboration between the radiology team, hospital management, and other related parties is key in ensuring that the new SPM reflects the current conditions post PACS implementation. Thus, hospitals can maximize the benefits of using PACS in increasing the efficiency of radiology services, improving the quality of patient care, and ensuring the security of patient data in this process.

Discussion

Radiology Service Time at UPTD Embung Fatimah Regional Hospital, Batam City After Implementing PACS

There are good changes after implementing PACS (Picture Archiving and Communication System) data on radiology services for outpatients for one month before implementing PACS, namely 67 patients, after implementing PACS, namely in August 2023 with a total of 67 patients. The average time before using PACS was 101.09 (minutes) while after implementing PACS there was a decrease of 65.61 (minutes) or a decrease in time of up to 35.3%. Based on testunpaired t-test shows that valuep-value 0.000 is less than 0.005, which means that the waiting time for outpatient expertise results is faster after implementing PACS.

There was a decrease in waiting time for expertise results in outpatients by 35.48 after implementing PACS. By reducing specialist waiting times for outpatients, the radiology unit can serve more patients in the same time period, thereby increasing the overall productivity and output of the radiology unit. This increased efficiency also extends to the diagnosis and reporting process, as radiology physicians can access and review images quickly and easily through the PACS system, thereby enabling timely and accurate reporting to referring physicians (Gottumukkala, Le, Duszak Jr, & Prabhakar, 2018). By simplifying workflows and reducing wait times, PACS improves the overall efficiency of radiology services, enabling better resource utilization and the provision of more effective patient care.

With shorter waiting times, patients can receive the reading results they need more quickly, resulting in better diagnosis and treatment planning (Alrasheedi, Al-Mohaithef, Edrees, & Chandramohan, 2019). So, when compared with the radiology service time currently adopted by UPTD Embung Fatimah Regional Hospital, Batam City, there is a fairly good reduction in service time for outpatients after implementing PACS.

Based on data on service time for inpatient radiology patients during the month before the implementation of PACS, there were 413 patients, while in August 2023, after the implementation of PACS, there were 439 patients who had statistical tests carried out using theMan whitney which shows that valuep-value 0.000 is less than 0.005 which can be interpreted as meaning that there is a difference in the waiting time for expert results for inpatients after implementing PACS. The average time before using PACS was 108.26 (minutes) while after implementing PACS there was a decrease of 61.90

(minutes) or a decrease in time of up to 41.04%. The mean result before implementing PACS was 101.09 (minutes) which shows the length of waiting time for expertise compared to the result after implementing PACS, namely 65.61 (minutes). So from here we get quite good differences in the application of PACS. If we compare radiology service times at UPTD Embung Fatimah Regional Hospital, Batam City with those before the implementation of PACS, there is a significant reduction in service time for inpatients after using PACS.

Data on radiology service times for Cito patients for one month before implementing PACS showed 153 patients, while in August 2023 after implementing PACS it showed there were 148 patients. The average time before using PACS was 104.26 (minutes) while after implementing PACS there was a decrease of 60.52 (minutes) or a decrease in time of up to 41.6%. Based on testMan whitney shows that valuep-value 0.000 is less than 0.005 which can be interpreted as meaning that there is a difference in the waiting time for CITO patient expertise results after implementing PACS. In this case, it is clear that there is a difference in radiology service time for Cito patients, which shows that the waiting time for expert results is faster. So in other words, implementing PACS can improve the waiting time for Cito patients.

This reduction in service time is a noteworthy development in the context of health services. This drastic reduction in service time can be explained by a number of key factors introduced by PACS. First, PACS allows storing and managing medical data, including radiology images and patient medical records, digitally and centrally. This eliminates the need for manual searches or physical transfer of data, which previously took quite a long time. With quick and easy access to this information, medical teams can make decisions more quickly, speed up the diagnosis process, and plan treatment more efficiently.

The implementation of PACS has a positive effect on radiology service time at the UPTD Embung Fatimah Regional Hospital, Batam City, both for outpatients, inpatients and CITO patients. Data shows that radiology service time was reduced drastically, with an average time of 65.61 minutes for outpatient services, 61.90 minutes for inpatient radiology services, and 60.52 minutes for CITO radiology services after implementing PACS. This reflects significant efficiency in managing radiology data and patient medical records. With quick and easy access to information, medical teams can make decisions more quickly, speed up the diagnosis process, and plan treatment more efficiently.

The positive impact of reducing service time also has an internal impact on Embung Fatimah Regional Hospital. Medical staff have more time to provide care to other patients or to perform other medical tasks, reducing fatigue and increasing productivity. In addition, resource management becomes more efficient, optimizing the use of radiology equipment and personnel and reducing operational costs related to long service times. Therefore, the implementation of PACS impacts the efficiency and long-term sustainability of healthcare institutions.

Although reducing service time has many benefits, it is necessary to monitor overall service quality. PACS must support high medical standards and patient safety. Continuous evaluation of PACS use and monitoring of time-to-service data are important steps to ensure that this positive impact is sustainable and can be improved over time.

Overall, the implementation of PACS has had a significant positive impact on the development of services at UPTD Embung Fatimah Regional Hospital, Batam City. This increases patient satisfaction, medical staff productivity, and resource management efficiency. However, ongoing attention to quality of care and careful monitoring is needed to ensure the benefits of PACS continue and improve the quality of health care in these institutions.

Perceptions of Radiologists and Radiographers Seen From the Quality of Radiology Services After Using the PACS System

Views of radiologists and radiographers regarding differences in the quality of radiology services before and after using the PACS system(Picture Archiving and Communication System) shows a change for the better in the efficiency and quality of radiology services in hospitals. First of all, in terms of speed of radiology services, both radiologists and radiographers agree that the use of PACS has resulted in real improvements. Previously, the radiology reading process took a long time, but with the adoption of PACS, the reading time has become shorter. This provides immediate benefits to patients with quicker diagnosis, which in turn can increase the chances of earlier cure or treatment.

The use of PACS also results in improvements in the accessibility of radiology data. Radiologist specialists reveal that they can now access radiology data from almost any location as long as it is connected to a network, which eliminates limitations in physical access to radiology films. This means doctors can quickly respond to emergency cases or consult with fellow doctors from various locations. In other words, PACS increases the mobility of radiology professionals and enables faster and more responsive service to patients.

Differences in service quality are also reflected in radiology data storage capabilities. Before PACS, manual storage and archiving of radiology data often made it difficult to find old photos for comparison. With the adoption of PACS, radiology images are stored in a digital format that can be quickly accessed via a computer or other device. This eliminates delays associated with searching for physical films and ensures that patient data is always available when needed. In other words, PACS allows radiology professionals to quickly access a patient's examination history, which facilitates more accurate diagnosis and better treatment.

Efficiency in radiology services is also reflected in the patient registration process. PACS integrates well with patient registration systems, enabling more structured and effective management. This not only speeds up the patient registration process, but also allows better use of data in tracking patient medical records. With this capability, hospitals can monitor patient progress over time and identify patterns that may be relevant for diagnosis and treatment.

Overall, the use of PACS not only brings increased efficiency in radiology services, but also produces direct benefits for patients in the form of faster and more accurate diagnoses. Moreover, better data access capabilities and structured storage improve the quality of radiology services and enable radiology professionals to provide better care. All of this contributes to improving the overall quality of radiology services in hospitals, having a significant positive impact on patients, medical staff and healthcare management.

Stakeholder Perceptions Regarding Analysis of the Speed of Radiology Service Time in Determining Minimum Service Standards (SPM) for Radiology After Using the PACS System

Perceptions of stakeholders (director, deputy director, medical support management, JKN unit head, radiology specialist doctor, and emergency room doctor/sender) regarding the analysis of the speed of radiology service time after using the PACS (Picture Archiving and Communication System) system at the Embung Fatimah Regional Hospital UPTD Batam City reveals a number of important aspects. First, the results of discussions from the FGD Team show that PACS has brought significant changes to the radiology service workflow. One of them includes increasing efficiency in the process of requesting photos, radiology examinations, and obtaining expert results. This process is now more efficient and better integrated, enabling better collaboration and communication between medical teams. In other words, PACS has optimized the workflow in radiology services in hospitals.

The positive impact of this change is very important in improving service quality. With a more efficient workflow, patients will get radiology examination results more quickly. The direct impact of these changes on the diagnosis and treatment process can be started earlier, which in turn can increase the patient's chances of recovery. In the case of patients requiring immediate treatment (Cito), reducing service time is key in saving lives or reducing the risk of complications. By adjusting the Radiology Minimum Service Standards (SPM) to reflect these changes, hospitals will effectively improve the quality of radiology services, providing direct benefits to patients.

Increased efficiency in radiology services is reflected in the accessibility of radiology data. With the adoption of PACS, patient data and radiology images can be accessed from any location with a secure and permission-compliant internet connection. This allows radiology professionals to quickly respond to requests, view and evaluate radiology images, and share expertise results. This speed in accessing radiology data is an important factor in ensuring rapid diagnosis and better care for patients.

The significant reduction in time in radiology services also has a positive impact on the overall quality of service. Patients will experience less waiting, discomfort and anxiety because radiology results can be provided more quickly. This contributes to increasing patient satisfaction, which is an important aspect in assessing the quality of health services. Patients who are satisfied with the service will tend to be more trusting and loyal to the hospital, which can support the positive reputation of RSUD Embung Fatimah.

Adjusting SPM to suit current conditions after PACS implementation, hospitals will be able to measure and monitor service quality better. The updated standards will reflect changes in service efficiency and ensure that hospitals remain committed to quality improvement. This could encourage continued efforts to improve radiology services in the future, including training radiology staff in optimal use of PACS, which in turn could improve service quality.

SPM adjustments also reflect the hospital's commitment to maintaining the security of patient data. With PACS, radiology data becomes more easily accessible digitally. Therefore, careful data protection and management is very important. SPM adjustments can include provisions governing the secure use of PACS, ensuring that patient data remains properly protected. This is a critical step in maintaining patient trust and carrying out ethical medical practices.

Overall, views and analysis from stakeholders show that the use of PACS has brought significant positive changes in radiology services at UPTD Embung Fatimah Regional Hospital, Batam City. This positive impact includes increased efficiency, data accessibility, service quality and patient satisfaction. By adjusting the SPM accordingly, hospitals will be able to ensure that service standards reflect these changes, resulting in radiology services that are more efficient, responsive, quality and safe for patients.

Research Limitations

One of the limitations of this research is that although qualitative data was obtained through interviews with stakeholders, and also interviews with radiographers and radiologists, the interpretation of the results is still limited to the perspective presented by the resource person or informant. Additionally, qualitative data is subjective and can be influenced by individual opinions.

Another limitation if viewed from a contextual perspective, is that the results of this research will depend greatly on the context and special characteristics of the Embung Fatimah Regional Hospital UPTD, Batam City. The results may not be directly applicable to hospitals or other health facilities that have different characteristics, but the results of this research will be a positive contribution in the learning and application of PACS as well as in relation to the adjustment of radiology SPM.

CONCLUSION

Based on research on the impact analysis of the implementation of the Picture Archiving and Communication System on minimum service standards in the field of radiology, conclusions can be drawn, namely:

1. The use of PACS significantly reduces radiology service time at the UPTD Embung Fatimah Regional Hospital, Batam City. There is a significant decrease in service time when compared to radiology SPM, namely 3 hours, in the previous outpatient service it was 101.09 minutes to 62 minutes or 35.3%, in the previous inpatient service it was 108.26 minutes to 65.6 minutes or 41.04% and in Cito patient service 104.27 minutes to 60.5 minutes or 41.06% after implementing PACS.
2. The use of PACS has increased the efficiency, speed and accessibility of radiology services. These changes have had a positive impact on the quality of radiology services, with faster and more accurate diagnoses and the ability to respond more quickly to patient requests.
3. Stakeholders realize that significant changes in the speed of radiology service times require adjustments to the Radiology Minimum Service Standards (SPM). These adjustments include accommodating changes in workflow and efficiency of radiology services. By adjusting the SPM accordingly, hospitals will be able to ensure that service standards reflect these changes, resulting in radiology services that are more efficient, responsive, quality and safe for patients.

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