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Development of an Android-Based CT Scan Examination Scheduling Information System at The Radiology Installation of Dr. H. Abdul Moeloek Hospital, Lampung Province

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ABSTRACT

The information system for scheduling CT scan examination with contrast at RSUD dr. H. Abdul Moeloek still uses a manual system by recording in the CT scan examination agreement logbook. This system causes inefficiency, delays in service and a high risk of errors. Therefore, it is necessary to develop an android-based system that is easily accessible and used by medical and administrative staff so that the quality of radiology services is improved. Objective To design and develop an android-based CT Scan examination scheduling information system at RSUD dr. H. Abdul Moeloek Lampung Province, test the feasibility or validation of the scheduling information system development and analyse the effectiveness of the development of an android-based CT Scan examination scheduling information system at RSUD dr. H. Abdul Moeloek Lampung Province. The method used is Research and Development (R&D). Expert validity test is guided by ISO 9126. The effectiveness test includes resource efficiency, time, cost, and service quality. The developed system is called 'SIPEDE CT Scan'. The results of the expert validity test based on ISO 9126 guidelines were 98.95% with very good criteria. The Asymp.Sig (2-tailed) effectiveness test result is 0.001 (<0.05), meaning that it can be said that there is an effect of using the CT Scan scheduling information system with android-based contrast on resources, time, costs and service quality. This study resulted in the development of an android-based CT Scan scheduling information system that is more effective and can improve service quality.

Keywords: Information System, Scheduling, CT Scan, Android

INTRODUCTION

The Radiology is one of the branches of medical science that uses imaging techniques of body structures in the form of shadows of various sizes, shapes and degrees of grayness to detect, diagnose and treat diseases (Chen MYM Ott DJ, 2011; Herring, 2020; Meredith WJ, 2013; Torigian D, 2017). Radiology is an important component of today's medical practice, which has taken a central role in the evaluation and follow-up of many clinical problems, from head to toe (Torigian D, 2017). Radiology modalities include conventional X-ray aircraft, Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET), Ultrasound (Ultrasound) and Computed Tomography Scan (CT Scan) (Zhang Z, 2019).

CT Scan is an imaging technique modality that utilizes X-rays to produce a cross-sectional image of the patient's anatomy by the way the patient will enter a rotating gantry. Inside the gantry are X-ray tubes and detectors that rotate as the patient passes through them, thus obtaining a continuous set of data (Hacking CP, 2023; Seeram, 2022). CT Scan overcomes the limitations of conventional X-ray plane modalities by eliminating the superposition of anatomical structures, improving image contrast, and imaging very small differences in tissue contrast (Seeram, 2022).

CT Scan examination is divided into 2 categories, namely CT Scan examination without contrast and CT Scan examination with contrast. The use of contrast media aims to visualize structures in organs or enhance visualization to obtain information about the function of a particular organ (Speck, 2018). In contrast to non-contrast CT Scans, CT Scan with contrast cannot be done immediately, because there are examination preparations before CT Scan with contrast, including fasting, cleaning the digestive tract by drinking English salt or dulcolax,

blood pressure checks, weight checks and ureum and creatinine laboratory checks to find out the estimated value of Glomerular Filtration Rate (eGFR) or kidney function. If the preparations made are not appropriate, the CT Scan examination with contrast may be postponed.

Contrast CT Scan requires preparation before the examination, closely related to the side effects that can be caused by the use of contrast media, ranging from minor to life-threatening physical impairment (Montazeran M Fatehi M, 2021). Contrast media side effects can be classified in several ways, but the most appropriate is based on the cause. Side effects of media contrast generally cannot be detected with a single mechanism. The type of contrast substance and its pharmacological properties, the examination technique used, such as the amount of dose and method of administration, and finally, the patient's attitude, such as fear, are all considered important contributing factors (Speck, 2018), therefore a CT Scan examination with contrast should be scheduled.

CT Scan as a diagnostic modality of ionizers is increasing (Latifah R, 2019). According to Schöckel, et al 2020 in their research article entitled Developments in X-Ray Contrast Media and the Potential Impact on Computed Tomography stated that there has been an increase in the number of CT Scan examinations by 4% per year worldwide with a total of 300 million scans per year and 40% of these examinations are requests for CT Scans with contrast (Schöckel et al., 2020). This is in line with data from dr. H Abdul Moeleoek Hospital in Lampung Province that there has been an increase in demand for CT Scans in contrast in the last 3 months, namely in July as many as 162 examinations, August as many as 185 examinations and in September as many as 193 examinations. Proportions for CT Scan examination According to Heyre, et al (2023) in their book it is stated that the most common CT Scan examination performed by most institutions as far as it knows is the head CT Scan without contrast 25%, CT Scan abdomen-pelvis with 20% contrast and 55% combined from CT Scan thorax with contrast, CT Scan of the pelvic abdomen without contrast, CT Angiography, and CT Scan Spine (Chau S, 2023).

Information technology has an important role in health services today, where the quality of information processing is an important factor for the success of health care institutions. According to WHO, an information system is a system that provides information for the decision-making process at every level in an organization. Hospital information systems (SIRS) are systems that integrate data collection, processing, reporting, and use of information needed to improve the efficiency and effectiveness of health services through better management at various levels of health services, while hospital management information systems (SIMRS) are information systems specifically designed to help.

Based on the Minister of Health of the Republic of Indonesia Number 82 of 2013, SIMRS is an information communication technology system that processes and integrates all hospital service processes in the form of a network of coordination, reporting and administrative procedures. An information system consists of data, people, and processes as well as a combination of hardware, software, and communication technology or known as information technology. A good information system can support clinical workflows in various ways that will contribute to better patient care, as mandated by Law number 44 of 2009 article 52 paragraph (Chen MYM Ott DJ, 2011) states that hospitals in Indonesia are obliged to record and report on all hospital implementation activities (Erma Kristanti Y, 2021).

Radiology as a supporting installation in hospitals has an information system that is integrated with other systems for medical procedures. According to The Royal Collage of Radiologists, a radiology information system or Radiology Information System (RIS) is a system designed to support operational workflows and business analysis within radiology departments. RIS is used as a place to store patient data, reports and contribute as an electronic

patient data recorder. RIS assists with administrative and operational functions regarding radiology such as registration, examinations, report results and scheduling (D White R, 2020).

RIS in its operation still uses a computer with a Local Area Network (LAN). LAN has several disadvantages, including the limited area of connection because it only covers the local area, if one of the computers connected in one network is infected with a virus, then the other computer will also be infected, the use of many computers connected to the LAN network will slow down its speed and the possibility of major hacks because it uses one network (Pujowati S, 2021). The use of various platforms as a forum in the development of RIS has been carried out a lot, including research conducted by Nurhayati on the use of websites as a medium for RIS (Nurhayati, 2024).

According to a survey conducted by the Indonesian Internet Service Providers Association (APJII) in 2020, 97.1% of Indonesians use androids. The percentage of internet use among women is 51% with the highest internet users being at the productive age at 65% (Ady, 2021; Ardiana, 2019; Desnelita Y, 2022; Erturk et al., 2019; Jibril, 2020; Krause D Ziada KM, 2020; Lampignano JP, 2018; Maranatha K Suharti E, Mulya Pratama G, 2023; Muhyi, 2018; Nugroho F, 2022; Rahmawati, 2020; Riyandi R, 2024; Subekti Rino & Sepriano S, 2023; Sumarni, 2019; Verdiansyah, 2016; Yuwana S, 2023; Zakariah MA Zakariah M, 2020). The duration of use is relatively high, which is more than 8 hours per day. The use of android as an information medium can make it easier for officers to access information quickly and can be done anywhere and anytime, this media also has an attractive appearance (Hadiati et al., 2022).

The researcher has collected information by interviewing administrative officers regarding the scheduling of CT Scan patients with contrast. From the results of the interview, it is known that the CT Scan patient scheduling system with contrast at dr. H. Abdul Moeloek Hospital, Lampung Province is still carried out manually by recording in the CT Scan patient agreement log book with contrast. To get to the stage of getting an inspection date, the flow is quite long. After the patient receives an introductory CT Scan examination form with contrast from the doctor in charge complete with the latest diagnosis and screening related to blood pressure and weight, the patient cannot immediately register at the radiology installation because they must include urea and creatinine values by way of examination in the laboratory which takes 2-3 hours until the results of ureum creatinine are obtained. Then the results of the examination are attached when registering for the CT Scan examination with contrast. Re-screening will be carried out by administrative officers related to a history of diseases such as heart disease and diabetes. Then the examination file is consulted with the radiological doctor, after obtaining the approval of the radiologist then the patient gets the scheduled examination schedule in the CT Scan patient agreement logbook with contrast.

Scheduling CT Scan examinations in contrast to manual methods like this is not effective and efficient because it is very prone to errors such as unclear writing, scattered files, missing or damaged examination introductions and patients not carrying out examination preparations. The use of an introduction to the examination that still uses physical files, requires archive storage space, so it is not effective and efficient over time due to the large number of files that must be managed. For inpatients, human resources are needed who are in charge of delivering the examination form. For CT Scan examinations with contrast examinations in direct review by radiologists, the examination is only carried out during morning working hours, with a limited time for contrast CT Scan examinations agreed with radiology specialists and radiographers in a day of 10 patients outside of cyto request. Meanwhile, the request for scheduling CT Scan patients with contrast based on patient data from January to August 2024 averages 15 patients per day. This makes the waiting time for patients to get an examination schedule even longer. One of the solutions to improve radiology services related to the scheduling system is to develop an android-based CT Scan examination scheduling information system.

The core problem addressed in this study is the inefficiency of the current manual scheduling system for contrast-enhanced CT scan examinations at Dr. H. Abdul Moeloek Hospital. The existing workflow relies on handwritten entries in logbooks, which are prone to errors, data loss, and procedural delays. As patient demand increases—averaging 15 cases per day—the limited capacity of radiology services combined with inefficient administrative handling results in prolonged waiting times and dissatisfaction among both patients and staff.

Furthermore, the current manual process is highly dependent on human resources and physical document verification, creating bottlenecks in scheduling and reducing the responsiveness of medical services. The lack of a digital system hampers the hospital's ability to deliver timely diagnostics, which are critical in patient management. A solution is therefore needed that allows flexible access, minimizes documentation errors, and accelerates administrative workflows through technology specifically, a mobile-based platform that aligns with the needs of a digital healthcare era.

The urgency of this research lies in the critical need for digital transformation within hospital systems, especially in radiology departments where timing, accuracy, and coordination are paramount. With rising demands for CT scan examinations, the continued use of a manual scheduling method undermines service efficiency and patient care. Developing a reliable and user-friendly Android-based scheduling system is essential to streamline processes, reduce waiting times, and support the hospital's transition to smart healthcare practices in line with Industry 4.0.

Previous studies, such as the one by Nurhayati (2023), have explored web-based radiology information systems (RIS) aimed at improving documentation and reporting processes in hospitals. While effective in local environments, these systems depend heavily on LAN networks and are not optimized for mobile use, limiting their flexibility and accessibility for dynamic medical workflows.

Another study by Hadiati et al. (2022) demonstrated the success of Android-based applications in improving health outcomes, particularly in maternal education. This research highlighted the practicality of mobile apps in delivering targeted, accessible, and timely information, making them highly relevant for hospital-based applications that require real-time communication and updates.

Widiyanto and Wulandari (2020) assessed the implementation of medical information systems using ISO 9126 standards and found that such frameworks are essential for ensuring software reliability and usability. However, their focus remained on electronic medical records (EMRs), and did not extend to the domain of radiology-specific scheduling or mobile applications, revealing a gap in specialized solutions for imaging departments.

Despite advancements in hospital information systems and mobile health (mHealth) technologies, there remains a gap in the literature regarding Android-based applications specifically designed for scheduling contrast-enhanced CT scan examinations. Most existing systems either cater to general administrative functions or lack the integration with clinical validation procedures. Moreover, few have been formally evaluated using standardized software quality metrics such as ISO 9126, indicating a lack of rigorously validated, mobile-compatible solutions for radiology scheduling workflows.

This research introduces a novel Android-based application tailored for scheduling contrast CT scan examinations, incorporating not only patient registration and scheduling functionalities, but also built-in educational resources for patients and real-time validation by radiologists. What sets this system apart is its adherence to ISO 9126 quality standards, ensuring it meets international benchmarks for functionality, usability, and efficiency. The system, named "SIPEDE CT Scan," represents an innovative step in digitizing specialized hospital workflows.

The main objective of this research is to design, develop, and validate an Android-based contrast CT scan examination scheduling information system at Dr. H. Abdul Moeloek Hospital. The system aims to enhance scheduling efficiency, reduce human error, improve access to examination data, and ultimately elevate the quality of radiology services by leveraging mobile technology for real-time coordination between medical staff.

This research offers practical benefits for healthcare institutions by providing a mobile-based scheduling platform that simplifies administrative tasks, accelerates patient processing, and reduces the risk of data loss or scheduling conflicts. The system also supports patient education and improves communication between departments. Its success can serve as a replicable model for digital transformation in other hospital units, contributing to the broader implementation of integrated health information systems across Indonesia.

METHOD

This type of research is Research and Development (R&D). This study aims to develop an Android-Based Contrast CT Scan Examination Scheduling Information System at the Radiology Installation of Dr. H. Abdul Moeloek Hospital, Lampung Province. The Research and Development (R&D) method is a research method used to produce certain products and test the effectiveness and efficiency of the product, in this case it is able to produce the latest products or models. Researchers collect data to produce products with descriptive methods while to test products with analytical methods (Yuwana S, 2023). Researchers developed an android-based application for scheduling CT Scans with contrast because so far, the scheduling system is still done manually. This study uses a 5-stage development model, namely (Sumarni, 2019; Zakariah MA Zakariah M, 2020):

Data Processing and Analysis Techniques

Data Processing

Data processing is a process to obtain data from each research variable that is ready to be analyzed. Data processing includes data editing activities, namely editing steps if deficiencies or incompleteness are found, data transformation (coding) i.e. data that has been collected is purchased with a suseai code with relevant categories, scoring, i.e. data is given an assessment score using a Likert scale, entry, which is the input of data into a computer so that it can be further analyzed, and data presentation so that complete data is obtained from each object for each variable studied (MA, 2024).

Data Analysis

Univariate Analysis

This analysis is used to see the overview of the frequency distribution of each variable that is studied. The frequency distribution with percentage or proportion size is used for categorical data, while numerical data (numbers) are described based on the middle or median value, average, and standard deviation (SD).

Bivariat analysis

Bivariate analysis is an analysis that is carried out to test the influence of intervention in the development of CT Scan scheduling information system with android-based contrast. Bivariate analysis aims to perform a difference analysis. First, normality testing was carried out using the shapiro wilk method because the data of each treatment was less than 50. If the data is normally distributed, bivariate analysts will continue with the Paired T-test and the Independent Sample T-test, but if the data is not normally distributed, the data analysis will be carried out using the Wilcoxon and Man-Whitney tests which are used to test the hypothesis of paired and unpaired samples before and after the intervention. The confidence level in the research used by the researcher is 95%, which means that the error percentage is 5%.

Descriptive analysis was carried out to describe the characteristics of the research data. In this case, the likert scale is used as a measurement tool to measure respondents' attitudes, opinions, or perceptions. The data from respondents' answers were analyzed using the percentage technique to show the proportion or part of the overall population. This descriptive analysis helps in understanding the general patterns and characteristics of the data collected.

RESULTS AND DISCUSSION

Research on the Development of an Android-Based CT Scan Examination Scheduling Information System with Contrast was carried out at the Radiology Installation of dr. H. Abdul Moeloek Hospital, Lampung Province. This research uses a research design with the Research and Development (R&D) method, namely, the researcher develops a new system that has never been applied at the Radiology Installation of dr. H. Abdul Moeloek Hospital, Lampung Province, where so far, the system used for scheduling CT Scans with contrast is still done manually.

Research on the Development of an Android-Based Contrast CT Scan Examination Scheduling Information System at the Radiology Installation of Dr. H. Abdul Moeloek Hospital, Lampung Province which was carried out discusses three objectives, namely making a design for the development of an android-based CT Scan examination scheduling information system , the results of validation of the quality of the development of the CT Scan examination scheduling information system with android-based contrast and the effectiveness of developing an information system for scheduling CT Scans with android-based contrast at dr. H. Abdul Moeloek Hospital, Lampung Province. The results of the research carried out consist of five stages including preliminary research, product development, product validation test by experts, product effectiveness test, and dissemination.

Preliminary Research

Preliminary research was conducted to obtain information, including:

Interview

Identifying the Model of the CT Scan scheduling system with Contrast at dr. H. Abdul Moeloek Hospital, Lampung Province as a consideration in making a design or development of a CT Scan scheduling system with contrast. Interviews were conducted with Radiology Specialists, DPJP and Radiology Administration Officers. The results of the interviews obtained are as follows:

Table 1. Description of respondents' answers to the question How many CT Scan examination requests with Contrast?

Source	Answer
Radiology Specialist	For a CT Scan examination with contrast for a day, the request that I approved could be 15 patients more, but we maximize the work of CT Scan examinations with this contrast a day of only 10 patients a day due to limited equipment, working time and human resources. So if the schedule is full on that day, it will be scheduled the next day, so that the waiting time for the inspection schedule will be long.
DPJP	For the number, I don't count for sure, only every day there must be someone I refer to for a CT Scan with contrast as a supporting examination to help establish the diagnosis and for post-treatment evaluation .
Administrative Officer	Requests for scheduling CT Scans with a day's contrast can reach 15 patients.

Table 2. Description of respondents' answers to the question How is the CT Scan scheduling system with contrast currently used?

Source	Answer
Radiology Specialist	In my opinion: the scheduling that is done is still manual and has limitations in terms of the time of approval of the examination because the checking of the request form must be checked directly, then when the CT Scan examination with contrast is carried out some patients have to be rescheduled due to poor examination preparation.
DPJP	In my opinion: to get a CT Scan schedule with contrast, the process is a bit long because there are several conditions that the patient must do such as a laboratory check for urea and creatinine values after that the patient can only go to radiology for scheduling, while scheduling is also still waiting for approval. For patients in prime condition, it may be okay, in contrast to patients who are dropping.
Administrative Officer	In my opinion: scheduling a CT Scan examination with contrast flow is quite long and the time required is long. For patients whose files are not complete, they are returned to the polyclinic, for patients who are complete, the files are collected first so that the consul to the radiologist is not one-by-one.

Table 3. Description of respondents' answers to the question Is a technology-based scheduling system such as an app on android required for CT Scan scheduling with contrast?

Source	Answer
Radiology Specialist	In my opinion: android-based applications are needed considering that we are currently in the 4.0 era which is required to be able to keep up with rapidly developing technology. With this application, it can also help the workflow so that it lightens the workload of officers.
DPJP	In my opinion: Changing the system to digital like this can ease the work. So this android-based application is needed
Administrative Officer	In my opinion: It is necessary, so that there are no more hardcopy files because they require special storage space, applications that keep up with technological developments can make work easier.

Table 4. Description of respondents' answers to questions What kind of technology-based applications are required for scheduling CT Scans with contrast?

Source	Answer
Radiology Specialist	In my opinion: An application that is user-friendly, easy to understand and that can improve the quality of radiology services
DPJP	In my opinion: an easy-to-use, eyecatching, easy-to-use app, it doesn't take long to learn
Administrative Officer	In my opinion: an application that can be accessed anywhere and anytime. An easy-to-use app.

Observation

Observations were made to determine the flow of scheduling CT Scan examinations with contrast. The flow of the CT Scan scheduling system with manual contrast at the Radiology Installation of dr. H. Abdul Moeloek Hospital, Lampung Province can be scanned as follows:

1. Patient Registration

   Patients from polyclinics or staff from inpatient rooms come to the registration counter to schedule CT Scan examinations manually.
2. Confirm Information on the CT Scan Examination Request Form and complete the file.

   The radiology registration officer will check the completeness of the files related to the CT Scan examination with contrast such as laboratory results and confirm to the patient or his

family regarding the examination to be carried out and medical information such as complaints, disease history, and other relevant information. If the file is complete and the information on the request form has been confirmed, the officer will submit the examination request form to the radiologist to make a contrast and herbicide prescription before the examination. However, if the documents are incomplete, the patient from the polyclinic or inpatient officer must return to the DPJP to make a request for a ureum and creatinine laboratory examination.

3. Scheduling by the Radiology Registration Officer.
   The enrollment officer then schedules the patient's CT Scan examination based on schedule availability, the type of examination required, and medical priorities. Examination schedule information is recorded in the examination schedule book, including the patient's identity, type of examination and the patient's or patient's family telephone number that can be contacted.
4. Education to patients, patients' families or room attendants
   The radiology officer educates the patient, the patient's family or the staff from the room about the schedule of the CT Scan examination and the preparations that must be made before the examination is carried out. After that, the patient, the patient's family or the officer from the room are asked to come according to the predetermined schedule.

From interviews and observations made, some of the problems that occurred during the use of the CT Scan patient scheduling information system with manual contrast were:

1. Less effective and efficient systems
   Manual processes tend to take longer and are prone to human error. This can result in delays in record-keeping, data processing, and decision-making, reducing overall operational effectiveness and efficiency.
2. Long wait times for examinations
   With manual systems, the registration, scheduling, and inspection processes often take longer. This can increase overall patient wait times, which can negatively impact the patient experience and service efficiency.
3. Scattered or missing inspection request form
   The inability to efficiently track and store documents digitally can result in documents being scattered or even lost. This can lead to difficulties in accessing the necessary information.
4. Requires Human Resources (HR) for the scheduling process.
   In the manual system, HR must actively contact various related parties, such as registration officers, doctors, and laboratory staff, to obtain available examination schedules. This process can be time-consuming and hinder responsiveness in handling urgent inspection requests.

From this preliminary research stage, information was obtained on problems arising from the manual system used for scheduling CT Scan examinations with contrast. Then suggestions related to the system to be developed so that it can be formulated, Scan, design, or design of the development of an information system for scheduling CT Scans with android-based contrast are carried out at the Radiology Installation of dr. H. Abdul Moeloek Hospital, Lampung Province.

Product Development

The information that has been obtained from preliminary research is the basis for consideration when developing products. The stages of product development consist of:

Design Products

The data collected from the preliminary research was used as the basis for designing the Development of a CT Scan Examination Scheduling Information System with Andorid-Based Contrast, carried out by compiling a flowchart to simulate the interaction between the user and the system, as well as an activity diagram as an illustration of the flow of the CT Scan scheduling process with contrast. Then a prototype is made that will be used for initial testing of validation by experts, namely professionals who have special expertise and knowledge in the related field.

Figure 1. Flowchart Development of CT Scan Examination Scheduling Information System with Android-Based Contrast

Figure 1 From the flowchart above, it can be seen that the main users of the development of this system are radiology and DPJP. The work area for radiology uses orange, the work area for DPJP uses green and the work area both use blue. The process starts from ordering the CT Scan examination with contrast, then selecting the examination date, filling in the patient's information and the type of examination that will be verified by the registration administration officer and then approved by the radiological doctor. Once approved by the radiologist the data will be sent to the DPJP account again.

Final Product Design Output

The design output of this android-based application is developed with the following menu display

Login menu view

Before entering the main menu of this application, users must register an account using an active email. After successful account creation, users enter their username and password. This login menu is used as an access right in the operation of the application. The following is a view of the product results of the development of an android-based CT Scan examination scheduling information system at dr. H. Abdul Moeloek Hospital, Lampung Province and instructions for its use.

1. Home Menu
   On the home menu there are 4 menus, namely:
2. Patient registration menu
   Menu that functions for scheduling Ct Scan patients with contrast contained in the DPJP account
3. Daily Work List Menu
   This daily work list menu contains a list of daily patients that must be worked on
4. Patient scheduling menu
   This scheduling menu serves to view the scheduling of patients who will perform the CT Scan examination with contrast
5. Notification menu
   This notification menu serves as a notification to the radiologist that there is a request for approval of the examination and the DPJP notifies when the scheduling request has been approved
6. Educational menu
   This educational menu serves as a medium in educating patients about everything about CT Scan examination with contrast

Product results of the development of an information system for scheduling CT Scan examinations with android-based contrast at dr. H. Abdul Hospital

a. Notification menu
   This notification menu serves as a notification to the radiologist that there is a request for approval of the examination and the DPJP notifies when the scheduling request has been approved
b. Educational menu
   This educational menu serves as a medium in educating patients about everything about CT Scan examination with contrast

Product development of CT Scan scheduling information system with adroid contrast at dr. H. Abdul Moeloek Hospital, Lampung Province. To be able to use the application that has been developed, you must first register an email. The stages for the DPJP account are as follows:

1) Open the SIPEDE CT Scan application that has been installed on the mobile android smartphone, a display like image (a) will appear, then click the 3-line symbol in the upper left corner to log in to the application. Enter the appropriate username and password in the fields provided as shown in the image (b).
2) After successfully logging in, a dashboard page will appear with several menus including patient registration and education menus. To order a CT Scan examination scheduling with contrast, select the patient registration menu on the application. Then click the (+) symbol to schedule a patient.
3) Fill in the requested patient information on the application, then press save to save patient data
4) The scheduling request has been recorded, then waiting for approval from the Radiology Specialist.

The results of the product development of an information system for scheduling CT Scan examinations with android-based contrast at dr. H. Abdul Moeloek Hospital, Lampung Province for Radiology Specialists and Administrative Officers.

1) Open the SIPEDE CT Scan application that has been installed on the mobile android smartphone, a display like image (a) will appear, then click the 3-line symbol in the upper left corner to log in to the application. Enter the appropriate username and password in the fields provided as shown in the image (b).
2) After successfully logging in, a dashboard page will appear with several menus, to view the patient's scheduling request click the notification menu
3) Click the booking menu to see the patient's request to be approved then click on the patient's name
4) Make sure all the information is filled in correctly and pay attention to the laboratory results for urea and creatinine values. Click the status menu to approve the request and check preparation on the description menu.
5) The CT Scan examination request has been approved, click the education menu to provide education on the preparation of the examination

System Validation by Experts

At the stage of system validation by experts, researchers have appointed two experts to evaluate and test the feasibility of the product development of an android-based CT Scan examination scheduling information system at dr. H. Abdul Moeloek Hospital, Lampung Province. After receiving input and feedback from expert validation, improvements and improvements are made to the system based on the suggestions given. This includes fixing flaws, improving functionality, and customizing based on user needs identified during the validation process.

Black Box Testing

Black Box Testing is a software testing method that focuses on the functional specifications of the software. The following are the results of Black Box Testing on the system conducted by DPJP, Radiology doctors and Radiology administrative officers. The purpose of Black Box Testing is to minimize the risk of defects in the system that has been created.

(a) Preliminary Research

Preliminary research is an important step in the development of information systems to ensure that the system built meets the needs of users and functions properly (Nugroho DY Heros PR, 2023). The development of an android-based contrast CT Scan scheduling information system is expected to be more effective and efficient, patient waiting time can be faster, there are no more scattered or lost documents, and the need for human resources can be minimized.

(b) Product Development

The development of an android-based contrast CT Scan examination scheduling information system product at dr. H. Abdul Moeloek Hospital, Lampung Province, there are several important stages in the development of an android-based contrast CT Scan examination scheduling information system at dr. H. Abdul Moeloek Hospital, Lampung Province, including:

1) System Design Analysis

The design analysis of the development of an android-based contrast CT Scan examination scheduling information system was carried out based on diagram activities that illustrate the workflow of the CT Scan examination scheduling process with contrast.

2) Needs Analysis

Collect information on the needs related to the scheduling of CT Scan examinations with contrast from all stakeholders through interviews, observations, and questionnaires. Information on needs related to scheduling CT Scan examinations in the form of examination lists, scheduling dates, and examination education.

3) Design Sistem
   a) Design Database
      The database design is efficiently designed to store scheduling data and patient information.
   b) User Interface Design
      The interface design is user-friendly that is easy to learn, clear navigation and attractive design for all categories of users to facilitate user interaction with the system.
4) System Installation
   The system is downloaded then installed on the user's android and post-installation testing is carried out to ensure the system works properly after installation.
5) User Training
   User training is for doctors, administrative officers, and other users on how to use the system, as well as guidelines are made for operating the system.
6) Maintenance
   Monitoring and maintenance of system performance is carried out to ensure that the system remains optimally working and to handle problems that arise quickly and efficiently.

(c) Validation of the system by experts

According to the Great Dictionary of the Indonesian Language (KBBI), an expert is a person who has expertise or expertise in a certain field. System validation by experts is carried out by validators who are competent in their fields, the expert in this study is someone who is competent in the field of information technology (Agustina & Asep, 2017). Comprehensive software product specifications and evaluations are key factors in ensuring the quality that can be achieved by defining the right quality characteristics by considering the objectives of the software product. Relevant quality characteristics. System quality validation was obtained from the results of expert validation tests using questionnaires guided by the six core characteristics of ISO 9126 which is the standard for measuring software quality assurance (Supriyono, 2019). System quality validation is carried out through several stages of comprehensive testing as well as the collection of feedback from users. This test involves evaluating functionality, reability, usability, efficiency, maintainability, and portability. The main advantage of ISO 9126 is its ability to cover a wide range of software types.

The results of the system quality validation test by experts are presented in table 4.12. According to the experts' assessment based on the quality test using the ISO 9126 standard, the functionality aspect, the reability aspect, the usability aspect, the efficiency aspect, the maintability aspect and the portability aspect, each aspect obtained a %expert assessment score and the total system quality validation score reached 98.95%, with excellent criteria. This indicates that the development of an android-based contrast CT Scan examination scheduling information system at dr. H. Abdul Moeloek Hospital, Lampung Province is feasible to use, in line with the research of Nur Hayati (2023) who uses ISO 9126 as an expert validation standard to test the quality of the system he developed, only there is a difference in the achievement value in his research which is 100% in the very good category.

(d) The effectiveness of the development of an android-based contrast CT Scan scheduling information system at dr. H. Abdul Moeloek Hospital, Lampung Province

Product effectiveness is a measure of how well the developed system meets the needs and provides benefits to its users (Ayu et al., 2021). The value of effectiveness is the conformity between the output and the set goal. Effectiveness focuses on the outcome or results of the information system developed is considered effective if the output produced meets the expected goals. The effectiveness value can be measured by comparing the pre-test and post-test

produced (Jibril, 2017). Evaluation of the effectiveness of the development of an android-based contrast CT Scan scheduling information system at dr. H. Abdul Moeloek Hospital, Lampung Province was carried out using the non-parametric Wilcoxon Signed Ranks Test on pre test and post test results. The test results showed a significant improvement in the post test, which included several key indicators, namely resources, time, cost, and quality of service, usability benefits, and user convenience.

This improvement can be seen in various indicators such as resource use efficiency, reduced time processing time, scheduling data, operational cost savings, and higher service quality. This new system not only meets technical and functional needs but also improves the overall user experience, ensuring that dr. H. Abdul Moeloek Hospital Lampung Province can provide better and more efficient services to patients.

CONCLUSION

Based on the results of the study, it can be concluded that the development of an Android-based contrast CT Scan examination scheduling information system at Dr. H. Abdul Moeloek Hospital has successfully addressed several issues inherent in the manual scheduling process. The system was developed using the Rapid Application Development (RAD) method in collaboration with third-party IT teams and is designed to facilitate quick and easy access for radiology administrative officers, radiographers, radiologists, DPJPs, and nurses. System validation, conducted by two experts and assessed using the six core criteria of ISO 9126 (functionality, reliability, usability, efficiency, maintainability, and portability), yielded a score of 98.95%, indicating excellent quality and system feasibility. Effectiveness testing using the Wilcoxon Signed-Rank Test showed significant improvement in all assessed variables—resources, time, cost, and quality of service—demonstrating the system's capability to enhance operational efficiency and service delivery. However, the system still faces limitations, including constrained human resources, potential internet connectivity issues, restricted development time, and certain features that have not fully met user expectations. Therefore, future researchers are encouraged to explore the integration of cloud-based infrastructure to improve accessibility and scalability, enhance user-centered design based on continuous feedback, and incorporate artificial intelligence for intelligent scheduling recommendations to further optimize hospital workflow.

REFERENCES

Ady, P. I. (2021). Buku Ajar: Pemrograman Mobile Berbasis Android (teori, latihan dan tugas mandiri) (1st ed. (ed.); Vol. 1). Lembaga Penelitian dan Pengabdian pada Masyarakat Universitas Dian Nuswantoro.

Agustina, D. A. I. L. S. D., & Asep, S. R. (2017). Pengembangan Media Pembelajaran Fisika Mobile Learning berbasis Android. Jurnal Penelitian & Pengembangan Pendidikan Fisika, 3(1). http://doi.org/10.21009/1

Ardiana. (2019). Perancangan Sistem Informasi Radiologi Guna Mendukung Peningkatan Pelayanan pada Pasien di Rumah Sakit Umum Daerah AL-Ihsan Pemprov Jabar ARDIANA. In Jurnal Teras Kesehatan (Vol. 2, Nomor 1). https://doi.org/10.38215/jutek.v1i2.7

Ayu, D. P. S. K., Brahma, P. G., & Ayu, S. N. N. (2021). Pengaruh Pemanfaatan Teknologi, Partisipasi Pemakai, Kemampuan Teknik Pemakai, Pengalaman Kerja dan Jabatan Terhadap Efektivitas Sistem Informasi Akuntansi. JURNAL KHARISMA, 3.

Chau S, H. C. M. (2023). Computed Tomography; A Primer for Radiographers. https://www.crcpress.com/

Chen MYM Ott DJ, P. T. L. (2011). Basic radiology. McGraw Hill Medical.

D White R, F. N. M. (2020). Accuracy of scanning the entire request information onto the Radiology information system (RIS). The Royal Collage of Radiologist.

Desnelita Y, I. (2022). Model Rekomendasi Karir Mahasiswa Sistem Informasi Menggunakan Sistem Pakar (Vol. 11). Samudra Biru.

Erma Kristanti Y, Q. A. R. (2021). Sistem Informasi Manajemen Rumah Sakit. Muhammadiyah Public Health Journal, 1(2).

Erturk, S. I. T., Saylisoy, S., & Ros, P. . (2019). Medical Imaging Contrast Agents: A Clinical Manual.

Hacking CP, L. D. A. (2023). Imaging for Students (F. Edition (ed.)).

Hadiati, L., Anggraeni, D., Korespondensi, P., Keperawatan, J., & L, L. (2022). Pengaruh Aplikasi Android Untuk Meningkatkan Pengetahuan, Sikap, Dan Keterampilan Ibu Hamil Dan Menyusui: Literature Review. Jurnal Perawat Indonesia, 6, 1119–1128.

Herring, W. (2020). Learning Radiology: Recognizing the Basics (4th ed. (ed.)). Elsevier Health Sciences.

Jibril, A. (2017). Efektivitas program perpuseru di perpustakaan umum Kabupaten Pamekasan. Jurnal Universitas Airlangga, 6(2), 1–8.

Jibril, A. (2020). Efektivitas program perpuseru di perpustakan umum kabupaten pamekasan.

Krause D Ziada KM, M. D. (2020). Nonrenal Complications of Contrast Media. In Interventional Cardiology Clinics (Vol. 9).

Lampignano JP, K. L. E. (2018). Bontrager's Textbook of Radiographic Positioning and Related Anatomy (Ninth (ed.)). Elsevier.

Latifah R, N. D. Z. (2019). Determination Of Local Diagnostic Reference Level (LDL) Pediatric Patients On Ct Head Examination Based On Size-Specific Dose Estimates (SSDE) Values. Jurnal Visi Kesehatan, 2, 127–133. http://www.e-journal.unair.ac.id/index.php/JVHS

MA, N. (2024). Pengolahan Data. Jurnal Ilmiah Sain dan Teknologi, 2.

Maranatha K Suharti E, Mulya Pratama G, W. C. S. (2023). Efektivitas Sistem Informasi Akuntansi: Apakah Itu Penting? 5(1), 15–33. https://journal.maranatha.edu/index.php/jafta

Meredith WJ, M. J. B. (2013). Fundamental physics of radiology.

Montazeran M Fatehi M, C. D. (2021). Patient Safety in Radiology. Textbook of Patient Safety and Clinical Risk Management, 309–318. http://link.springer.com/10.1007/978-3-030-59403-9_22

Muhyi, M. (2018). Metodologi Penelitian (1st ed. (ed.); Vol. 1). Adi Buana University Press.

Nugroho DY Heros PR, M. M. (2023). Studi Pendahuluan atau Kajian Relevan. Pendas: Jurnal Ilmiah Pendidikan Dasar, 8.

Nugroho F, A. H. (2022). Determinasi simrs: hardware, software dan brainware. 3(1). https://doi.org/10.38035/jmpis.v3i1

Nurhayati. (2024). pengembangan sistem informasi.

Pujowati S, B. H. B. (2021). Pengenalan Dasar Jaringan Komputer (1st ed. (ed.); Vol. 1).

Rahmawati, F. (2020). Aspek Laboratorium Gagal Ginjal Kronik. Jurnal Ilmiah Kedokteran Wijaya Kusuma, 6(1), 14–22.

Riyandi R, K. R. (2024). Sistem Informasi Persediaan Beras (Vol. 6).

Schöckel, L. S. P., Lengsfeld P, P. P., & Pietsch H, J. G. (2020). Developments in X-Ray Contrast Media and the Potential Impact on Computed Tomography. Invest Radiol, 55(9), 592–597.

Seeram, E. (2022). Computed Tomography: Physics and Technology A Self Assessment Guide.

Speck, U. (2018). X-Ray Contrast Media.

Subekti Rino, L. L., & Sepriano S, A. Y. (editors). (2023). Buku Ajar Pengantar Ilmu Komputer (1st ed. (ed.)). PT. Sonpedia Publishing Indonesia.

Sumarni, S. (2019). Model Penelitian dan Pengembangan (R&D) Lima Tahap (MANTAP).

Supriyono, S. (2019). Penerapan ISO 9126 Dalam Pengujian Kualitas Perangkat Lunak pada E-book. MATICS, 11(1), 9.

Torigian D, R. P. (2017). Radiology Secret Plus.

Verdiansyah. (2016). Pemeriksaan Fungsi Ginjal. CDK, 43, 237.

Yuwana S, I. T. (2023). Metode Penelitian Dan Pengembangan (Research & Development) Dalam Pendidikan Dan Pembelajaran. UMMPress.

Zakariah MA Zakariah M, A. V. (2020). Metodologi Penelitian Kualitatif, Kuantitatif, Action Research, Research And Development (R N D) (1st ed. (ed.); Vol. 1). Yayasan Pondok Pesantren Al Mawaddah Warrahmah Kolaka.

Zhang Z, S. E. (2019). Radiological images and machine learning: Trends, perspectives, and prospects. Computers in Biology and Medicine, 108, 354–370.