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Implementation of Digital Signatures in the Integrated Patient Progress Notes System at XYZ Hospital Bandung

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Abstract: This study aims to implement a digital signature system for filling out Integrated Patient Progress Notes (CPPT) using QR-Code technology. The research method employed is the waterfall development model. The stages of the study include requirements analysis, data collection from various sources, system design, implementation according to the design, testing, and reporting. The study was conducted at XYZ Hospital in Bandung, where it was found that the CPPT signing process is still manually done using a pen, which is considered inefficient as it takes a long time for authorization and is prone to manipulation, thereby reducing the document's validity. The implementation of a digital signature aims to simplify the document signing process quickly without the need for printing, sending, or waiting for physical documents, allowing it to be done digitally and automatically, thereby increasing speed and efficiency. This system also provides authentication assurance by the rightful owner, ensures document security, reduces the risk of damage or loss, and minimizes the possibility of manipulation, thus providing convenience for staff and doctors in terms of time and data accuracy.

Keywords: CPPT System; Digital Signature; QR-Code.

1. Introduction

The development of information systems across various sectors, including healthcare, has rapidly advanced towards digitalization, making processes more accessible and efficient [1]. One significant advancement in healthcare information systems is the electronic medical record (EMR), which offers numerous benefits in improving the quality of healthcare services [2]. According to the Indonesian Ministry of Health Regulation No. 24 of 2022, medical records are documentation that includes patient identity, examinations, treatments, procedures, and additional services provided to patients. Electronic medical records differ significantly from conventional ones. Digitalization allows for better data categorization and fosters innovation in medical technology. Additionally, electronic medical records play a crucial role in developing artificial intelligence (AI) systems, which enhance the quality of healthcare services while providing legal certainty in the management and maintenance of medical records. Furthermore, electronic medical records ensure the security, confidentiality, integrity, and accessibility of medical data. The Directorate General of Health Services (2015) explains that the Integrated Patient Progress Notes (CPPT) is a collection of data that stores information about the patient's condition, progress, medical actions, and treatments received [3]. Healthcare providers use CPPT to plan, monitor, and evaluate patient conditions. The CPPT form is used in inpatient, outpatient, and emergency settings to monitor patient health progress across various disciplines (doctors, nurses, and other clinical staff) and to collect relevant information on patient conditions and appropriate treatment options.

According to Article 1, Paragraph 12 of the Indonesian Law No. 19 of 2016 on Electronic Information and Transactions (ITE Law), an electronic signature is defined as a signature consisting of electronic information attached, associated with, or related to other electronic information used for verification and authentication. Government Regulation No. 71 of 2019 on the Implementation of Electronic Systems and Transactions (PP PSTE) states that both certified and uncertified electronic signatures are recognized. Furthermore, this regulation distinguishes the legal strength between certified and uncertified electronic signatures. Sholeh & Muharom (2016) describe Quick Response Code (QR Code) as a two-dimensional symbol capable of storing various types of information that can be accessed through smartphone scanning [4]. QR Codes, which evolved from barcodes, were initially one-dimensional but have now developed into two-dimensional formats [5]. QR Codes, first introduced by Denso Wave in 1994, have become a widely used and essential technology in the digital era. QR Codes facilitate data recording, data transfer, and payments and can store up to 2,089 digits or 4,289 characters, including punctuation and special characters. This technology can display text, open URLs, save contacts to phonebooks, and perform various other functions. The development of information technology systems brings significant changes to healthcare services, educational systems, administrative services, and various other aspects of life [6][7]. In this study, an uncertified electronic signature system was developed for completing the Integrated Patient Progress Notes (CPPT) form using QR Codes. As information technology systems continue to evolve, it is necessary to transition from manual to digital methods to reduce the risk of document manipulation and simplify the creation of new documents that match the original. Documents, as vital sources of information for organizations, governments, agencies, or individuals, must be well-preserved to avoid data loss for future activities [8].

This study began with a review of previous research related to the use of QR Codes as digital signatures. Research conducted by Suratma and Azis (2017) discussed the use of QR Codes with the Advanced Encryption Standard (AES) algorithm as digital signatures, which were applied in digital signature authentication systems and document verification [9]. Kurniawan *et al*. (2020) studied how to create a document validation system using QR Code-based digital signatures with the MD5 algorithm, which is the standard for digital signatures. This system is designed to issue and validate digital documents while reducing the likelihood of forgery [10]. Based on the research conducted at XYZ Hospital in Bandung, it was found that the current process of signing the CPPT form is still done manually using a pen. Given the advancements in digital technology, this manual system is considered inefficient as it requires a lengthy process, including printing documents and waiting for physical signatures, and is prone to manipulation, which reduces the validity of the signature. To address this issue, the researchers designed an uncertified digital signature system for use in completing the CPPT form at XYZ Hospital in Bandung. This system allows the signing process to be done digitally and automatically, thus increasing the speed and efficiency of services.

2. Research Method

The research methodology employed in this study is descriptive qualitative research, which aims to depict or explain the core issues using observational methods. The development method used is the Waterfall Model,

one of the most common software development approaches, also known as the Life Cycle of Software Development (LDC). The Waterfall Model is characterized by its sequential stages, where each step is completed before moving on to the next, much like water cascading down a series of steps. This model is widely recognized for its systematic approach to software development, allowing for a structured and orderly progression through the various phases of the project.

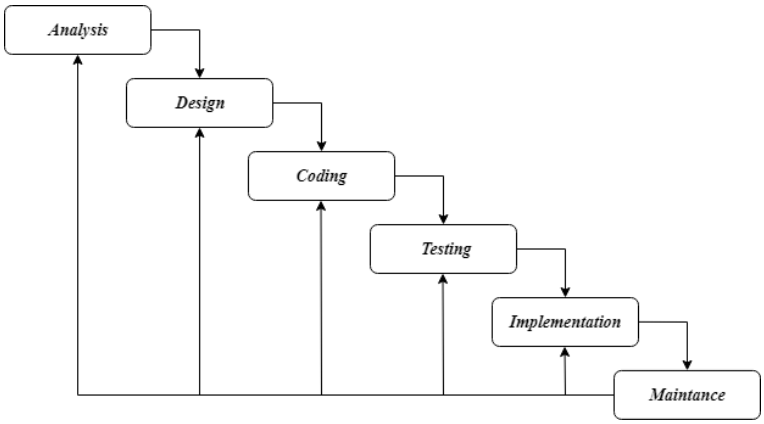

Figure 1. Waterfall Model

The first phase in this research, known as the analysis phase, involves a comprehensive understanding of the software to be developed, including its expected features and potential weaknesses. The researchers begin by gathering detailed information about the requirements and expectations for the digital signature system to be implemented in the Integrated Patient Progress Notes (CPPT) forms. This stage includes discussions with hospital staff to understand the current challenges faced with the manual signing process and to identify the specific needs that the new digital system must address. Data collected during this phase is meticulously analyzed to ensure that the researchers have a clear and accurate understanding of the problems and requirements, which will guide the subsequent stages of development [11]. Following the analysis, the design phase is undertaken, where the system's architecture and user interfaces are created. In this study, the researchers used Visual Studio Code to design the digital signature system. This phase is crucial as it translates the requirements identified during the analysis into a workable system design. The design includes creating forms and interfaces that users will interact with, ensuring that the system is both user-friendly and functional. The design also considers the integration of QR-Code technology, which will be used for the digital signatures, ensuring that the system is secure and capable of meeting the hospital's needs. The next stage is coding, where the actual development of the software begins. This involves writing the code that will enable the system to function as designed. The researchers focused on developing each form and function identified in the design phase, ensuring that the code is robust and capable of handling the system's requirements. Each form is carefully coded to ensure that the digital signature system operates smoothly within the Visual Studio Code environment. The coding phase is a critical step in the software development process, as it transforms the design into a functional system. Once coding is complete, the testing phase begins. During this phase, all the small units of code created in the previous stage are integrated and tested as a whole. The system undergoes rigorous testing to identify any errors or bugs that need to be addressed. The goal is to ensure that the software meets the user requirements and functions as intended. If any issues are found, they are corrected, and the system is retested until it performs satisfactorily. This phase is vital in ensuring that the system is reliable and ready for deployment. The final phase in the Waterfall Model is implementation. In this stage, the fully tested system is deployed for use within the hospital. This involves setting up the system in the hospital's environment, training staff on how to use the new digital signature system, and ensuring that it integrates seamlessly with existing processes. The implementation phase marks the culmination of the project, where the system is expected to me*et all* the user requirements identified at the beginning of the project. By following the structured approach of the Waterfall Model, the researchers ensure that each phase of development is thoroughly completed, resulting in a reliable and effective digital signature system for the hospital.

3. Result and Discussion

3.1 Results

The research conducted at XYZ Hospital in Bandung revealed that the system for signing the Integrated Patient Progress Notes (CPPT) form lacked a digital signature component. According to the Ministry of Health Regulation No. 24 of 2022, all healthcare facilities are required to support and maintain electronic medical records [3][6]. At XYZ Hospital, the CPPT form is still signed manually using a pen, a method considered inefficient and prone to manipulation, which diminishes the validity of the signatures. Implementing a digital signature system provides authenticated verification by the rightful owner, ensuring document security, reducing the risk of damage or loss, and minimizing the potential for manipulation. Additionally, it offers convenience for healthcare staff and doctors in terms of time efficiency and data accuracy. To support integrated healthcare services, a digital signature system was developed using Visual Studio Code to streamline the signing process for the CPPT form at XYZ Hospital.

3.1.1 Analysis

The analysis phase of this study involved a thorough evaluation of the existing manual signature process used for the CPPT form at XYZ Hospital. The research identified significant inefficiencies and risks associated with human error in this manual process. To address these issues, the researchers proposed the development of a digital signature system using Visual Studio Code, integrated with a Microsoft Access database. This combination was selected to streamline data processing, reduce human error, and enhance both the speed and accuracy of data management for healthcare staff and patients. The existing system's primary flaw was its reliance on manual signatures, which is susceptible to delays and potential manipulation. The manual process requires physical interaction with documents, which can lead to errors, loss, or damage. The adoption of a digital signature system aims to mitigate these risks by providing a more secure and efficient method for document verification and management. The analysis highlighted the necessity of integrating this digital solution to meet the regulatory requirements and improve overall operational efficiency at the hospital.

3.1.2 Design

The design phase is a critical component of the system development process. During this phase, the researchers created a detailed plan to address the identified issues and ensure the system's functionality and reliability. The design process involved applying various principles and techniques to outline the system's processes, architecture, and components necessary for achieving the desired outcomes. The digital signature system's design was conceptualized using several modeling tools, including flowmaps, Data Flow Diagrams (DFD), context diagrams, and Entity-Relationship Diagrams (ERD).

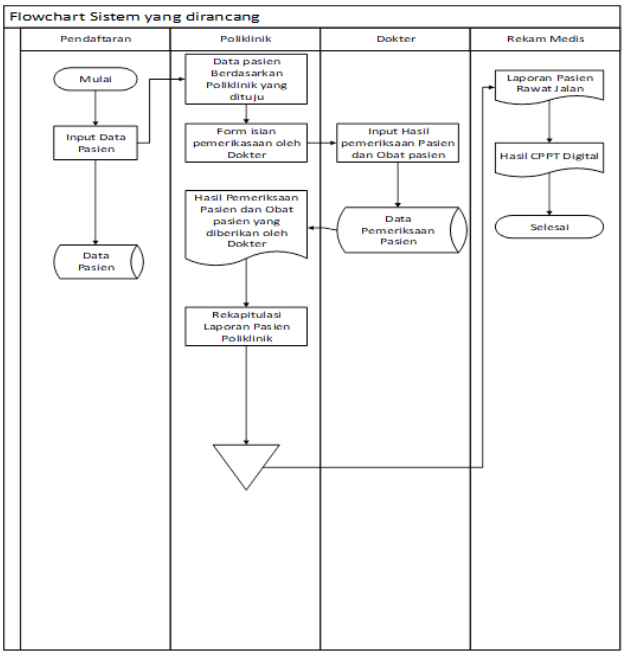

Figure 2. Flowchart of The Designed System

Figure 2 illustrates the flowchart of the designed system. Flowcharts are essential tools in system design as they provide a visual representation of the system's workflow, depicting the sequence of operations that must be executed to achieve the desired results. According to Tania (2020), flowmaps combine maps and flow diagrams to show the steps required to solve a problem, such as the movement of objects from one location to another [12]. This approach aids programmers and analysts in breaking down complex problems into smaller, manageable parts and helps analyze alternative operational strategies.

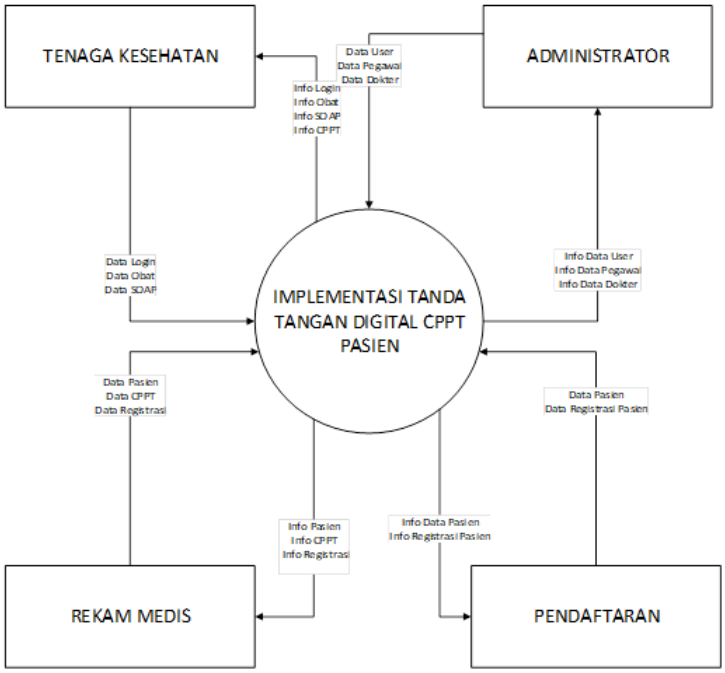

Figure 3. Context Diagram

Figure 3 presents the context diagram, a vital part of the DFD. As noted by Ahmad Hasanudin (2021), the context diagram provides an overview of the entire system and is required before creating the DFD, which offers a more detailed view of the system's processes and features [13]. The context diagram illustrates the boundaries of the system, identifying external entities that interact with the system and the flow of data between these entities and the system.

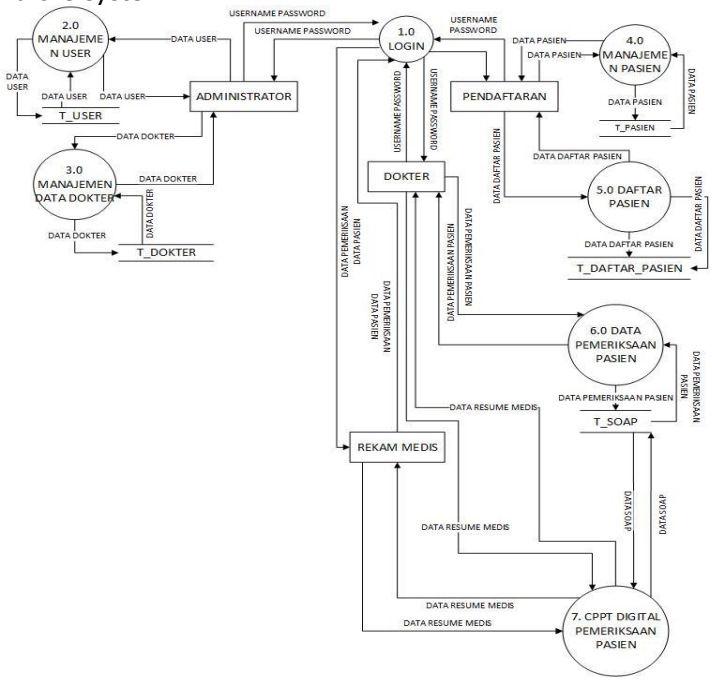

Figure 4. DFD Level 1

Figure 4 shows the Data Flow Diagram (DFD) Level 1, representing the logical flow of the system without considering the physical environment where the data is stored or processed. The DFD is structured into several levels, each providing increasing detail about the system's processes. These levels are interconnected to offer a comprehensive understanding of the information system or software processes. The DFD Level 1 diagram highlights the primary processes within the system, showing how data moves through the system and interacts with various components.

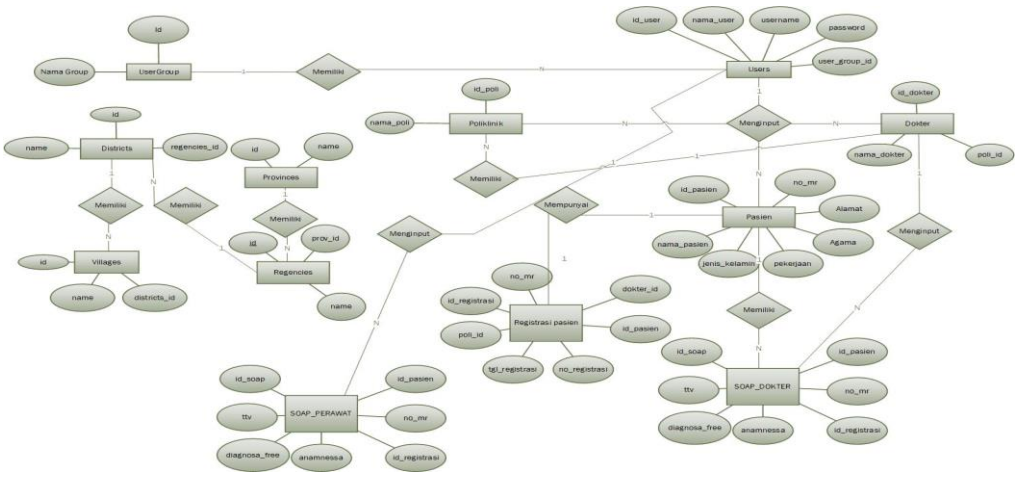

Figure 5. Entity Relationship Diagram (ERD)

Figure 5 depicts the Entity-Relationship Diagram (ERD), also known as a relationship diagram between entities. According to Maimudin (2021), the ERD consists of three key components: entities, attributes, and relationships [14]. The ERD complements the database's logic by detailing the relationships between entities, defining their attributes, and setting constraints. The primary purpose of the ERD is to fulfill the system's analytical needs within the database, ensuring that all necessary relationships are correctly established to support the system's operations.

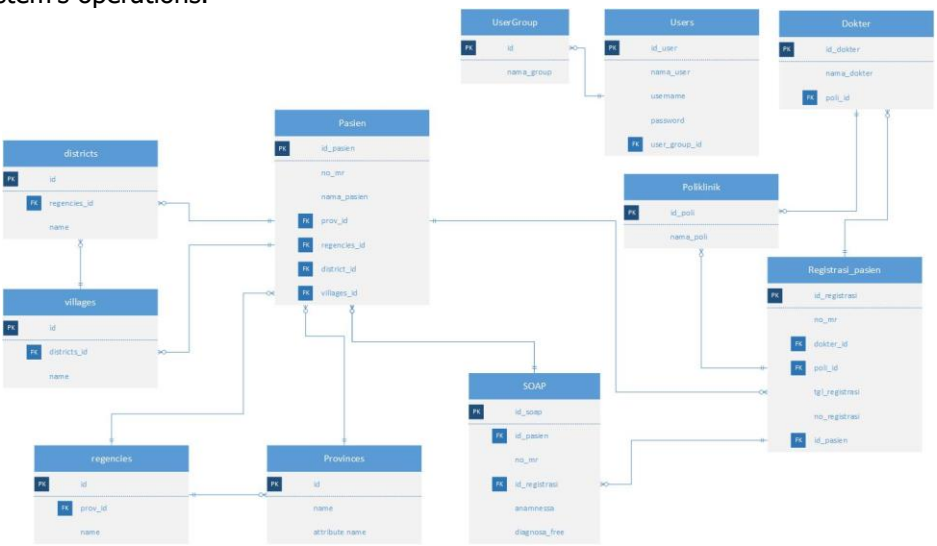

Figure 6. Table Relation

Finally, Figure 6 illustrates the table relationships in the relational data model. As Abdul Kadir (2014) states, the relational data model uses a set of two-dimensional tables (often referred to as relational tables), with each table comprising rows and columns [11]. These tables are interconnected through relationships that define how data in one table relates to data in another. The design phase was instrumental in ensuring that the system's architecture was well-structured and capable of supporting the digital signature system's requirements.

3.1.3 Coding

The coding phase marked the transition from design to actual development. In this phase, the system's functionalities, as outlined in the design phase, were implemented through code. The coding process involved developing the necessary code for each form and function specified in the design documentation to ensure that the system operates seamlessly within the Visual Studio Code environment. This phase is critical as it transforms the conceptual design into a functional digital signature system. The coding was performed with a focus on accuracy and efficiency, ensuring that the system's logic was correctly implemented and that all functionalities worked as intended. Special attention was given to the integration of the digital signature component with the QR Code technology, which was central to the system's ability to authenticate and secure documents. The use of Visual Studio Code allowed for a streamlined coding process, providing the tools necessary to build a robust and reliable system. The coding phase culminated in a fully operational system, ready for testing and implementation.

3.1.4 Testing

Testing is a crucial phase in the system development lifecycle, ensuring that the system functions correctly and meets the requirements set out in the design phase. In this study, the system was subjected to blackbox testing, which focuses on evaluating the system's functionality from the user's perspective without delving into the internal workings of the code. The primary goal of blackbox testing is to identify any errors, bugs, or discrepancies that may exist within the system and to ensure that these issues are resolved before the system is deployed. During the blackbox testing phase, the system was evaluated across multiple scenarios, each designed to test a specific aspect of the system's functionality. The testing results are presented in Table 1. This table outlines the various testing scenarios, the expected outcomes, the actual results, and the conclusions drawn from the testing process. The blackbox testing phase was instrumental in identifying any issues that needed to be addressed, ensuring that the system was fully functional and ready for deployment.

Table 1. Blackbox Testing Results

No	Description	Testing Scenario	Expected Result	Test Result	Conclusion
1	Form Login	Enter correct username and password, click the login button	User successfully logs in	Login successful	Match
2	Patient Data Form	Complete all patient data fields and click save	System displays "Data Saved!"	Data saved successfully	Match
3	Patient Registration Form	Enter polyclinic and doctor's name for patient visit	System displays "Data Saved!"	Data saved successfully	Match
4	Doctor's Examination Form	Complete examination data according to SOAP standards	CPPT form successfully created	CPPT form created	Match
5	CPPT Print Form	Enter all required data and click print	System prints CPPT form	CPPT form printed	Match
6	Digital Signature Scanning	System should accept, process, and display the QR Code	QR Code successfully scanned	QR Code scanned	Match

During blackbox testing, some discrepancies were identified, as detailed in Table 2, with corresponding solutions provided in Table 3. The testing phase ensured that the system was reliable, functional, and capable of meeting the needs of XYZ Hospital.

3.1.5 System Implementation

The implementation phase is the final step in the system development process, where the fully tested and functional system is deployed in the real-world environment. For this study, the digital signature system was implemented at XYZ Hospital in Bandung. This phase involved setting up the system within the hospital's infrastructure, training staff on how to use the new system, and ensuring that it integrates seamlessly with existing processes. The system was implemented using Visual Studio Code, which provided a stable platform for deploying the digital signature system. The implementation included the configuration of the database, setting up user accounts, and ensuring that all forms and functionalities were operational. The system's security features, particularly the digital signature and QR Code integration, were thoroughly tested to ensure

they provided the necessary protection for sensitive patient data. Figure 7 shows the initial login screen, which is the primary entry point for accessing the system. The login screen was designed to be user-friendly and secure, allowing only registered users to access the system. This ensures that sensitive patient data and system functionalities are protected from unauthorized access. Figure 8 displays the main menu, which acts as the central hub for all data entry and management tasks within the digital signature system. The main menu includes options for managing staff data, doctor data, polyclinic data, patient data, doctor worklists, nurse worklists, and digital CPPT forms. Each of these options leads to specific forms and functionalities designed to streamline the workflow and ensure accurate data management.

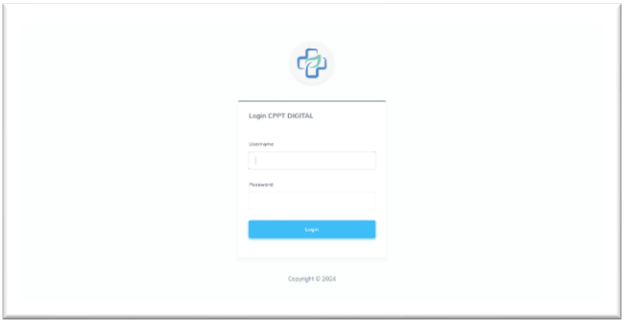

Figure 7. Initial Login Screen

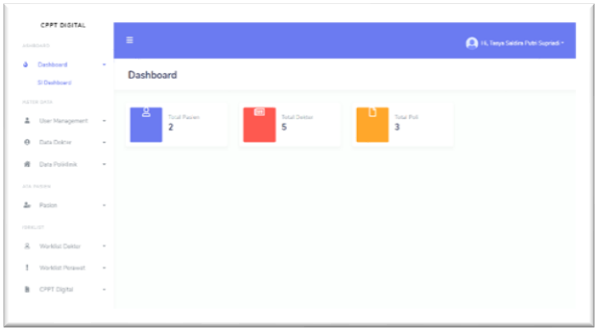

Figure 8. Main Menu

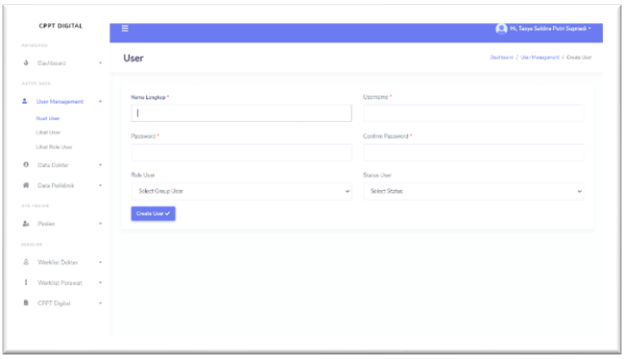

Figure 9. Staff Data Form

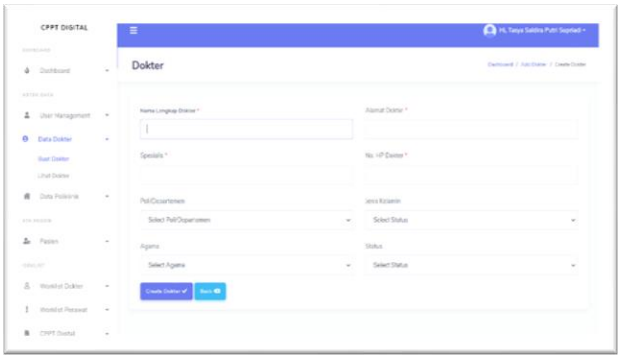

Figure 10. Doctor Data Form

Figures 9 through 13 provide detailed views of the various forms used within the system. Figure 9 shows the staff data form, which captures essential information about the hospital staff, including names, usernames, passwords, user roles, and status. Figure 10 displays the doctor data form, which includes fields for capturing doctor-specific information, such as name, specialty, department, religion, address, phone number, gender, and status. Figure 11 illustrates the polyclinic data form, used to manage information about the various polyclinics within the hospital. This form includes options for adding new polyclinics and managing existing ones. Figure 12 presents the patient data form, which captures social and identification data about patients. This form is critical for ensuring that all patient information is accurately recorded and easily accessible within the system.

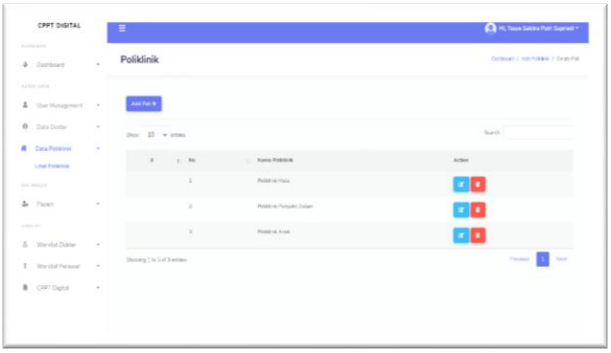

Figure 11. Polyclinic Data Form

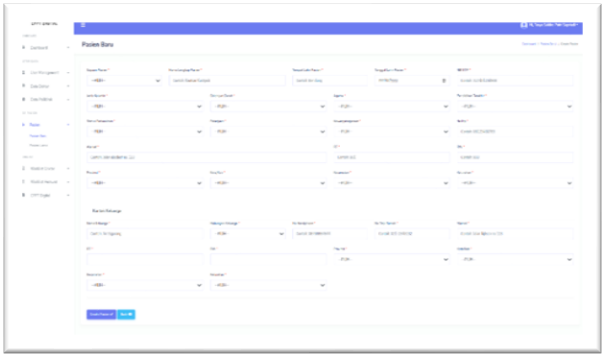

Figure 12. Patient Data Form

Figure 12 shows the patient registration form, which is used to register patients for appointments at various polyclinics. This form captures essential information, such as patient ID, visit date, polyclinic, and attending doctor. The form is designed to be intuitive and easy to use, ensuring that patients can be registered quickly and efficiently. Figures 13a and 13b depict the SOAP form, which is used by doctors and nurses to input examination data. This form is crucial for documenting patient conditions, treatments, and progress, providing a comprehensive record of patient care. Once the examination is complete, the CPPT can be printed directly from the system.

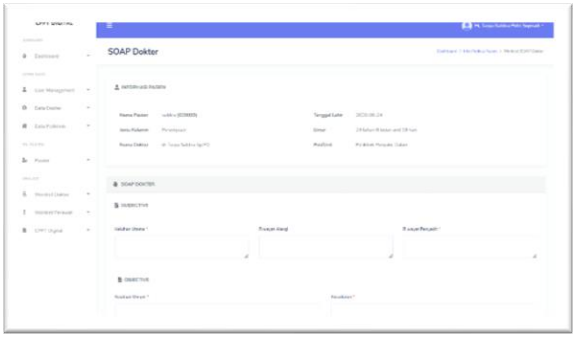

Figure 13a. SOAP Form (Part 1)

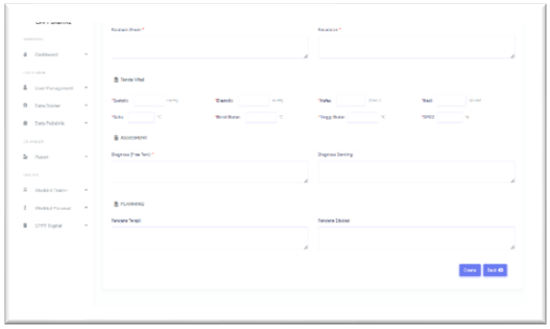

Figure 13b. SOAP Form (Part 2)

Nama Pasien : saldira
No. RM : 000003
Tanggal Lahir : 24 Jun 2000
Jenis Kelamin : Perempuan

RS . XYZ BANDOENG

CATATAN PENGEMBANGAN PASIEN TERINTEGRASI

Tanggal Periksa	Profesional Pemberi Asuhan (PPA)	Hasil Assesment dan Pemberian Pelayanan	Review dan Tth Digital Dokter
13 Jul 2024	Tasya Saldira Putri Supriadi	**Subjective :** Keluhan Utama : demam batuk flu mual muntah sudah 3 hari Riwayat Alergi : tidak ada Riwayat Penyakit : tidak ada Keadaan Umum : sakit sedang Kesadaran : sadar **Objective :** *Tanda Vital :* Bp Systolic = 120, Bp Diastolic = 40, Nafas = 20, Nadi = 83 , Suhu = 38.5 , Berat Bdn = 43 Kg, Tinggi Bdn = 161 cm, Oxygen Saturasi = 96 %, *Keadaan Umum :* sakit sedang *Kesadaran :* sadar **Assesment** *Diagnosa (Free Text)* fever **Planning** *Rencana Terapi :* kontrol tgl 24/07/24 *Rencana Edukasi* -	

Figure 14. Patient Progress Record Form

Finally, Figure 14 illustrates the final output of the digital signature on the integrated patient progress notes. This output was developed using Visual Studio Code and successfully implements an uncertified digital signature using QR Code technology. The implementation of this system at XYZ Hospital represents a significant improvement in the management and security of patient records. During blackbox testing, some discrepancies were identified, and these are detailed in Table 2, with solutions provided in Table 3.

Table 2. Functional Discrepancies

No	Form Name	Description of Discrepancy	Number of Discrepancies
1	Form Login	User unable to log in with registered account	0
2	Patient Data Form	Patient data could not be saved	0
3	Patient Registration Form	Registration cannot be saved if polyclinic is not entered	0
4	Doctor's Examination Form	Incomplete SOAP form data prevents CPPT printing, potential human error	1
5	CPPT Print Form	Unable to print the document	0
6	Digital Signature Scanning	QR Code cannot be scanned	0

Table 3. Solutions for Discrepancies

Discrepancy Area	Description of Discrepancy	Solution
Doctor's Examination Form	Incomplete SOAP form data prevents CPPT printing, potential human error	Revise coding in the examination form to provide error notifications and avoid human error

3.2 Discussion

The implementation of a digital signature system in the Integrated Patient Progress Notes (CPPT) form at XYZ Hospital in Bandung represents a significant shift from traditional paper-based processes to a more efficient and secure digital workflow. This discussion will explore the implications of this transition, the challenges encountered during the implementation, and the broader impact on healthcare delivery at the hospital. One of the primary motivations for adopting a digital signature system was to enhance the efficiency and accuracy of the CPPT process. The manual signing process, which required physical documentation, was prone to delays and errors. These issues were particularly problematic in a hospital setting where timely and accurate documentation is crucial for patient care. The transition to a digital signature system, as implemented through Visual Studio Code and Microsoft Access, has streamlined the signing process, significantly reducing the time required to complete documentation. The ability to sign documents digitally means that healthcare providers can now complete forms more quickly, reducing the administrative burden and allowing them to focus more on patient care. Moreover, the digital system minimizes the risk of errors associated with manual entries. In the previous system, errors could occur during the transfer of information from paper to the hospital's electronic records, potentially leading to discrepancies in patient data. The digital signature system integrates directly with the hospital's database, ensuring that all entries are consistent and accurate. This integration not only improves the quality of the documentation but also enhances the overall reliability of the hospital's medical records.

Another critical factor in the implementation of the digital signature system is the need to enhance the security of patient records. As highlighted by the Ministry of Health Regulation No. 24 of 2022, all healthcare facilities are required to maintain electronic medical records, which include ensuring the security and confidentiality of patient data. The manual signing process was vulnerable to manipulation, where unauthorized individuals could potentially alter or forge signatures. This posed significant risks to the integrity of the hospital's records and could have legal repercussions. The digital signature system addresses these security concerns by incorporating advanced authentication mechanisms, such as QR Code integration, to verify the identity of the signatory. This ensures that only authorized personnel can sign and access sensitive patient documents, thereby safeguarding the integrity of the records. The use of QR Codes provides an additional layer of security, as it allows for the easy verification of the document's authenticity by simply scanning the code. This feature not only protects the documents from tampering but also ensures that the hospital complies with legal standards for electronic records. The implementation of a digital signature system also aligns with global trends in healthcare, where digital documentation is becoming the norm. Hospitals and healthcare facilities worldwide are increasingly adopting digital systems to manage patient records, reduce paperwork, and improve the security of medical information. By implementing this system, XYZ Hospital is positioning itself at the forefront of this digital transformation, ensuring that it meets both current and future regulatory requirements.

Despite the clear benefits, the transition to a digital signature system was not without challenges. One of the primary challenges was ensuring that all healthcare staff were adequately trained to use the new system. The shift from a manual to a digital process required a significant change in workflow, and there was initial

resistance from some staff members who were accustomed to the traditional methods. To address this, the hospital implemented a comprehensive training program to ensure that all users were comfortable with the new system and could use it effectively. Another challenge was the integration of the digital signature system with the existing hospital information systems. The hospital's IT infrastructure needed to be upgraded to support the new system, including the installation of necessary software and hardware. This required careful planning and coordination to avoid disruptions to the hospital's operations. The use of Visual Studio Code and Microsoft Access facilitated this integration, as these tools are flexible and compatible with a wide range of systems. However, there were still technical issues that needed to be resolved during the implementation phase, particularly related to the compatibility of different software components. The testing phase, as detailed in the results section, also revealed some functional discrepancies that had to be addressed before the system could be fully deployed. These issues were primarily related to the user interface and the accuracy of the data entry process. The blackbox testing identified specific areas where the system's performance did not meet expectations, and solutions were implemented to correct these issues. This iterative process of testing and refinement was crucial to ensuring that the final system was both functional and reliable.

The successful implementation of the digital signature system has had a positive impact on healthcare delivery at XYZ Hospital. By reducing the time required for documentation, healthcare providers can now dedicate more time to patient care, improving the overall quality of service. The system's ability to ensure the accuracy and security of patient records has also enhanced the hospital's reputation as a provider of high-quality, secure healthcare services. Additionally, the digital signature system has streamlined the hospital's administrative processes, reducing the need for physical storage of documents and making it easier to retrieve and manage patient records. This has resulted in cost savings for the hospital, as less paper is used, and storage requirements are reduced. The system's efficiency has also led to faster processing times for patient admissions, discharges, and other administrative tasks, further improving the patient experience. The system's compliance with legal standards has also mitigated potential legal risks for the hospital. By ensuring that all patient records are securely signed and stored, the hospital has reduced the likelihood of legal disputes related to the authenticity of documents. This is particularly important in cases where patient records may be used as evidence in legal proceedings. The digital signature system provides a clear audit trail, making it easier to verify the authenticity of records and ensuring that the hospital is protected in the event of a legal challenge.

Looking ahead, the implementation of the digital signature system at XYZ Hospital serves as a model for other healthcare facilities considering similar transitions. The success of this project demonstrates the feasibility and benefits of adopting digital systems in healthcare, particularly in improving efficiency, security, and compliance with regulatory standards. Future developments could include the expansion of the digital signature system to other areas of the hospital's operations, such as billing and insurance processing, where similar benefits could be realized. Additionally, there is potential for integrating the digital signature system with other emerging technologies, such as blockchain, to further enhance the security and transparency of patient records. The hospital could also consider conducting further research to evaluate the long-term impact of the digital signature system on patient outcomes and overall hospital performance. This could involve tracking key performance indicators, such as the time taken to complete documentation, the accuracy of patient records, and the incidence of data breaches or security incidents. Such research would provide valuable insights into the effectiveness of the system and help identify areas for further improvement. The implementation of a digital signature system in the CPPT process at XYZ Hospital represents a significant advancement in the hospital's operational capabilities. The system has successfully addressed the inefficiencies and security risks associated with manual documentation, providing a more efficient, accurate, and secure method for managing patient records. Despite the challenges encountered during the transition, the system has proven to be a valuable asset to the hospital, enhancing the quality of healthcare delivery and ensuring compliance with legal and regulatory standards.

4. Related Work

The implementation of digital signatures in healthcare, particularly in the patient development records at Rumah Sakit XYZ Bandung, marks a significant advancement in ensuring the authenticity and integrity of medical documentation. The evolution of digital signature systems has played a crucial role in overcoming the challenges of transitioning from paper-based records to electronic health records (EHR). This shift highlights the need for secure and efficient methods of document authentication, which digital signatures effectively provide. Research demonstrates that integrating digital signatures into EHR systems enhances the security and reliability of patient records, thereby fostering trust and compliance with regulatory standards [15][16].

Digital signatures offer a robust solution for ensuring the authenticity and integrity of medical records. By utilizing cryptographic techniques, digital signatures protect sensitive patient information from unauthorized access and modifications. For example, the combination of digital signatures with encryption technologies has been proven to significantly strengthen the security of patient data, ensuring that only authorized personnel can access and alter these records [17][16]. This level of security is especially important in medical environments where the accuracy of information directly impacts patient care and treatment outcomes. The incorporation of biometric data into digital signature systems has also shown promise in enhancing security. Biometric signatures, which use unique physical characteristics such as fingerprints or facial recognition, provide an additional layer of verification that is particularly valuable in healthcare settings where the identity of the signatory must be definitively established. This approach not only reinforces the authentication process but also aligns with the growing trend towards personalized and secure healthcare solutions [18]. The integration of QR codes with digital signatures has become increasingly popular in healthcare settings. QR codes enable the linking of physical documents with their digital counterparts, allowing for easy verification of authenticity through scanning. This method streamlines the verification process and reduces the risk of forgery or tampering, thereby improving the overall efficiency of document management in healthcare facilities. Implementing such technologies can significantly enhance hospital workflows, making the transition to digital documentation more seamless [19][20].

User adoption remains a key factor in the successful implementation of digital signature systems in healthcare. Research shows that systems with user-friendly interfaces and comprehensive training programs achieve higher adoption rates among healthcare professionals [15][21]. This is critical to ensuring that the benefits of digital signatures are fully realized, as ease of use is directly related to the effectiveness of these systems in practice. Training programs that adequately prepare healthcare staff to use digital signature systems contribute significantly to the smooth adoption and long-term success of these technologies. Furthermore, the legal and regulatory framework surrounding healthcare documentation has a significant influence on the adoption of digital signatures. Various regulations require the implementation of secure methods for managing patient records, and digital signatures are increasingly recognized as a vital tool in meeting these requirements [16][22]. Compliance with these regulations not only protects patient privacy but also reduces potential legal risks associated with improper handling of sensitive information. Aligning digital signature technologies with regulatory standards ensures that healthcare facilities meet necessary legal obligations while enhancing the security and integrity of their documentation processes.

The implementation of digital signatures in patient development records at Rumah Sakit XYZ Bandung involves multiple factors including technical, operational, and regulatory considerations. The integration of advanced technologies such as encryption, biometrics, and QR codes, along with a focus on user adoption and regulatory compliance, establishes digital signatures as a key element in modern healthcare documentation practices. The continued development and improvement of these systems will likely play a crucial role in the ongoing digital transformation of healthcare, ensuring that patient records are managed securely and efficiently in an increasingly digital landscape.

5. Conclusion

Based on observations made by researchers, it can be concluded that the process of making a signature on the integrated patient progress record (CPPT) form is still done manually using a pen which is considered inefficient because it requires a fairly long process. This allows for easy manipulation which reduces the validity of the signature. For this reason, it is necessary to create a digital signature information system program so that in the process of making an integrated patient progress record (CPPT) letter, human error can be minimized. In this study, with the existence of a digital signature system in filling out the integrated patient progress record (CPPT) form, it is expected that it can be used digitally or automatically, can improve the services of a health agency more quickly and efficiently, and provide convenience for officers and doctors in terms of time and also the data requested.

References

[1] Siagian, S. (2016). Analisis ancaman keamanan pada sistem informasi manajemen di Rumah Sakit Rimbo Medica Jambi 2015. *Scientia Journal, 4*(04), 371–375.

[2] Amatayakul, M. K. (2013). *Electronic health record: A practical guide for professionals and organizations* (5th ed.). AHIMA.

[3] Peraturan Pemerintah Nomor 71 Tahun 2019 tentang Penyelenggaraan Sistem dan Transaksi Elektronik.

[4] Muharom, L. A., & Sholeh, M. L. (2016). SMART presensi menggunakan QR-Code dengan enkripsi Vigenère cipher. *Limits: Journal of Mathematics and Its Applications, 13*(2), 31. https://doi.org/10.12962/j1829605x.v13i2.1933

[5] Lorien, A., & Wellem, T. (2021). Implementasi sistem otentikasi dokumen berbasis Quick Response (QR) code dan digital signature. *Jurnal RESTI (Rekayasa Sistem dan Teknologi Informasi), 5*(4), 663–671.

[6] Dirjen Bina Upaya Kesehatan RSUP Persahabatan. (2015). *Panduan catatan pasien terintegrasi (CPPT)*. KEMENKES RI.

[7] Ferzha, M., Murfiq, H., & Rizkian. (2022). Implementasi tanda tangan digital pada surat keterangan bebas laboratorium.

[8] Kementerian Kesehatan Republik Indonesia. (2022). *Peraturan Menteri Kesehatan Nomor 24 Tahun 2022 tentang rekam medis*. Kementerian Kesehatan Republik Indonesia.

[9] Suratma, A. G. P., & Azis, A. (2017). Tanda tangan digital menggunakan QR code dengan metode Advanced Encryption Standard. *Techno, 18*(1), 59–68. https://doi.org/10.30595/techno.v18i1.1482

[10] Kurniawan, R., Sari, R. F., & Azizah, N. (2020). Sistem validasi keaslian dokumen digital berbasis QR-Code. *Jurnal Teknologi Informasi, 4*(2), 321–327. Retrieved from http://www.jurnal.una.ac.id/index.php/jurti/article/viewFile/1722/1468

[11] Abdul Kadir. (2014). *Pengenalan sistem informasi edisi revisi*. Andi.

[12] Tania, V. R. (2020). Perancangan sistem informasi penggajian karyawan pada CV. TRI MULTI JAYA Yogyakarta. *Jurnal Sistem Informasi dan Sains Teknologi, 2*(1). https://doi.org/10.31326/sistek.v2i1.669

[13] Hasanudin, A. (2021). *Contoh DFD dan diagram konteks*. guratgarut.com.

[14] Maimudin, N. I. (2021). *Pengertian, fungsi, model dan contoh ERD*. tisucoding.com.

[15] Anshari, M. (2023). Persiapan implementasi tanda tangan digital untuk autentikasi dokumen rekam medis elektronik di RSUD Dr. H. Moch Ansari Saleh Banjarmasin. *Jurnal Kajian Ilmiah Kesehatan dan Teknologi, 5*(2), 64–70. https://doi.org/10.52674/jkikt.v5i2.112

[16] Abdurrachman, T., & Suteja, B. (2021). Pengembangan sistem informasi asosiasi jasa konstruksi dengan menerapkan tanda tangan digital. *Jurnal Teknik Informatika dan Sistem Informasi, 7*(1). https://doi.org/10.28932/jutisi.v7i1.3431

[17] Norhikmah, N. (2023). Application of 2DPCA and SOM algorithms to identification of digital signature ownership. *Faktor Exacta, 16*(3). https://doi.org/10.30998/faktorexacta.v16i3.17504

[18] Kim, T., Ngoc, D., & Moldovyan, N. (2023). Constructing representative collective signature protocols using the GOST R34.10-1994 standard. *Computers Materials & Continua, 74*(1), 1475–1491. https://doi.org/10.32604/cmc.2023.029253

[19] Wellem, T., Nataliani, Y., & Iriani, A. (2022). Academic document authentication using elliptic curve digital signature algorithm and QR code. *Joiv International Journal on Informatics Visualization, 6*(3), 667. https://doi.org/10.30630/joiv.6.2.872

[20] Pal, K., & Kumar, S. (2020). QR code based smart document implementation using blockchain and digital signature. In *Advances in Blockchain Technology and Digital Economy* (pp. 449–465). https://doi.org/10.1007/978-981-15-5616-6_32

[21] Halimatusaadah, H., & Hidayati, M. (2022). Analisis kelengkapan pengisian rekam medis pasien RJ poli umum guna menunjang mutu rekam medis. *J-Remi Jurnal Rekam Medik dan Informasi Kesehatan, 3*(2), 159–168. https://doi.org/10.25047/j-remi.v3i2.2737

[22] Ramadhanty, A., Rumana, N., Dewi, D., & Yulia, N. (2022). Pelepasan informasi medis kepada pihak ketiga di rumah sakit (literature review). *Sehatmas Jurnal Ilmiah Kesehatan Masyarakat, 1*(1), 16–24. https://doi.org/10.55123/sehatmas.v1i1.30.

