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Web-Based Patient Referral System Design from Clinic to Hospital Using Object Oriented Programming System

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Abstract

The clinic in Tangerang Regency, Indonesia is a healthcare institution where people seek treatment and medical advice. However, the patient referral system to the hospital in the polyclinic still uses the old method, which involves a letter of introduction from the clinic, a conventional way of documenting the chronology of the patient's illness and using a certificate or cover letter at the clinic. Patient data with problems going to the hospital is not stored in the database, and as a result, patients may have to postpone going to the hospital. The purpose of this study is to determine the current patient referral system from clinics to hospitals and design a web-based patient referral information system that can integrate patient data into the hospital. This research uses a descriptive qualitative method to analyze and design the system, employing the Object-Oriented System Design method. The output of this research is software, which is a web-based patient referral information system that displays completed patient data and disease chronology accurately and quickly, supporting digital concepts.

Keywords: Information, System, Object-Oriented, Patient, Referral

1. INTRODUCTION

With the rapid development of technology, healthcare institutions are required to move quickly and efficiently to carry out institutional activities, such as external patient referral services from clinics to referral hospitals [1, 2]. A clinic is a polyclinic that provides health services for the community on a 24-hour basis, with the availability of inpatient and emergency facilities [3]. However, the use of patient referral information systems at clinics is still conventional in the process of providing referral letters to patients, collecting drug data, drug prescriptions, patient data, and patient diagnosis data [3]. To resolve this issue, the use of software can provide enormous benefits to the clinic [3, 4].

The hospitals in Tangerang Regency are still implementing outpatient referral services along with patient referrals to the Emergency Department. With many

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patients seeking treatment, patients have to queue to get a patient referral letter to the hospital [5]. This condition takes a long time for the patient and makes it impossible to predict when treatment services will arrive at the hospital. By establishing an online patient referral information system, the problems with the current referral system can be resolved.

The problem formulation of this research is twofold: 1) What is the current patient referral system at clinics in Tangerang Regency? 2) How can we build an online patient e-referral information system at a clinic in Tangerang Regency? The method used is qualitative [6]. In system analysis and design, object-oriented methods with UML tools are used [7, 8]. The way to gather data for research is to come directly to the field, then ask some questions and study the literature [9].

The purpose of this study is to determine the current patient referral system from the clinic to the hospital and design a web-based patient referral information system so that patient data can be integrated quickly and accurately into the hospital. This research produces software, namely an electronic referral information system at an online clinic, which can display information on referred patient data and the patient's disease chronology, so that hospitals can support digital concepts. The clinic can display detailed information on referred patient data, find out the diagnosis of the referring patient's illness, as well as data on the nearest referral hospital, and display a map of the hospital's location.

The importance of this research can be seen from several studies such as those conducted by Abdolalizadeh, P., Kashkouli, M. B., Gandomi-Mohammadabadi, A., Karimi, N., Chaibakhsh, S., and Jafarpour, S. compared web-based and non-web-based patient referral patterns and identified the factors affecting them. The methods involved collecting demographic data, and the results showed a significant increase in the use of web-based referral sources [4]. Another study by Aman, M., Sasono, I., Nugroho, Y. A., Riyanto, and Suroso analyzed how object-oriented system approaches can improve sales through e-commerce utilization. This qualitative study resulted in the development of web-based information system software [10]. Harindra and Oktavia, L. D., developed a web-based application for early detection of high-risk maternal referral system in the islands region (SIDILAN) in South Bangka Regency. The quasi-experimental research method with pre and post-test one group design was used, and the results showed that using risk factors or scores can reduce delays in early detection and referral [11].

Soeripto, D. N. conducted research entitled "The Implementation of Clinical Procedures in the Vertical Referral System in a Primary Healthcare Center," which examined the first-level hospital patient referral system [12]. Safhira, S., Indriyani, W., and Sonia, D. developed a web-based information system for BPJS patient referral letters in UPT Puskesmas Gumuruh using field and literature research

methods, as well as the waterfall system development method. The result of this research was web based BPJS patient referral letter information system software [13]. Mahfudz, M. O. H. A. M. A. D., conducted research on "Pemetaan Sistem Rujukan Badan Penyelenggara Jaminan Sosial Kesehatan (BPJS) Berbasis Sistem Informasi Geografi," using a geographic information system (GIS) to collect spatial data and time accuracy. The study showed that Bogor city had 17 hospitals and 25 health centers, with all health centers being in the first-level category [14]. Nugroho, Y. A. et al. researched the design of a web-based patient referral system from clinic to hospital, using an object-oriented programming system and qualitative methods. The study produced information system software with digital or web-based concepts.

2. METHODS

The author employed qualitative methods in their research, with the aim of presenting systematic, accurate, and relevant insights into the characteristics of the study location. The use of the qualitative approach allowed for a comprehensive depiction of the research subject, from the initial design stage to the culmination of the investigation [6], [15]. The researchers carried out our study at a clinic in Tangerang Regency, following the subsequent steps, as shown in figure 1.

2.1. Data Analysis Method

In analyzing the patient referral information system at the current clinic, the following steps were taken [16]:

a) The researchers obtained data by directly interviewing the owner of the clinic in Tangerang Regency, asking about current constraints, and gathering information on the patient referral service process.
b) The data obtained was then analyzed, providing an overview of the previous systems and the current process.
c) The researchers identified system requirements and proposed a system by analyzing the current process.
d) Specifications for the designed patient referral service were identified, including determining the necessary software.

2.2. Data Collection Method

To obtain data for the study, the researchers used the following methods [17]:

a) Direct questioning: The researchers asked relevant sections within the clinical department questions related to building a patient referral information system, functional and non-functional needs, and the system's users, using a structured direct questioning technique.

b) Field observation: The researchers directly observed the related department and the object under study. They followed structured observation techniques and compiled a list of data uses and sources. This method helped the researchers to understand patient referral documents, company structure, business processes, technology used, and the information technology SAP available at the general doctoral department in a clinic in Tangerang Regency.

c) Library study: The researchers obtained data by studying research papers, books, and journals related to the patient referral information system.

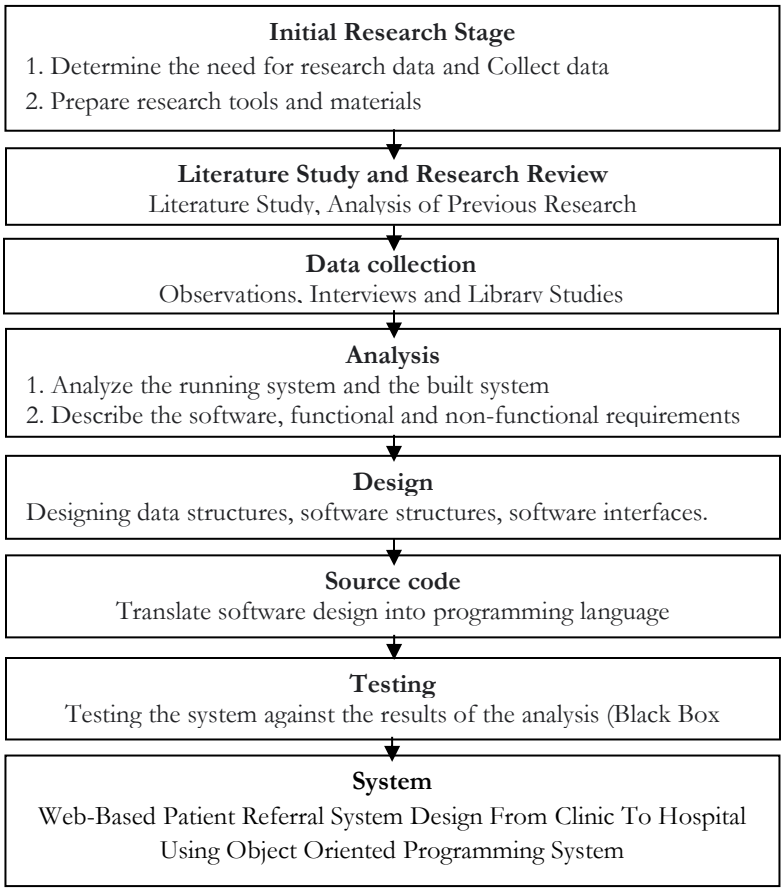

Figure 1. Research steps in system design

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2.3. System Design Method

The author employs the method of design to analyze the results. The analysis is described in detail using Unified Modeling Language (UML) tools [18] [19] [21]. The UML diagram includes the following:

a) Use Case Diagrams: These diagrams depict the functionality of the system design and describe the interaction between system users (actors) with predetermined steps.
b) Activity Diagram: This diagram describes the flow of functionality in a system and can be used as a needs analysis to depict the flow of events through use cases.
c) Sequence Diagrams: These diagrams explain in detail the processes or messages carried out in the system to achieve the goals of the use case.
d) Class Diagrams: These diagrams illustrate the set of classes, interfaces, collaboration, and relationships between objects.

3. RESULTS AND DISCUSSION

The researchers employed Unified Modeling Language (UML) tools to analyze the results of the study and build a new patient referral system. In this system, a patient visits the clinic, registers, and is diagnosed by a doctor. If the clinic lacks the necessary facilities, the patient is referred to the nearest hospital. The doctor records the patient's illness and gives a referral letter to the nearest hospital so that the patient can receive specialist treatment [19], [22].

Before constructing the system, the researchers conducted an analysis to ensure that it would meet user requirements. By analyzing the system, the researchers were able to determine the actions necessary to use the system, who could use it, and when it could be implemented. The author utilized object-oriented system analysis to design the application, with a focus on the system's functionality. To visualize and implement the patient referral system, the researchers used UML diagrams, including four diagrams as shown below [23]:

3.1 Use Case Diagrams

These diagrams describe the actions of actors and users in the application design. The system design involves four actors, including the admin, doctor, patient, and manager/owner. Patients must register before logging in, and all actors require login credentials to access the system. The user interface allows input of user, patient, doctor, and diagnostic data, as well as referral data. Additionally, users can view referral patient reports, while admins can print such reports. Managers and owners can view referral patient data reports [20]. See Figure 2 for more details.

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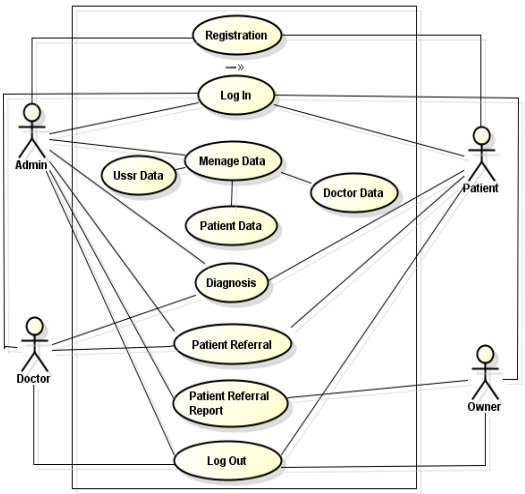

Figure 1. Use Case Diagrams Designed System

3.2. Activity Diagrams

Activity Diagrams are a useful tool for designing process flows for inputting data into the system. One such diagram is the registration activity diagram, which is used by patients to input data into the system according to the system flow [20]. The process starts when a patient opens the app, and the system displays the registration page. The patient then inputs the registration data and clicks the save button. The system validates the data and if complete, saves the registration data. If not, the patient is returned to the registration page to enter the missing information.

Another important Activity Diagram is the Login Activity Diagram, which allows users who have registered their data to access the application. This diagram outlines the flow of activities involved in verifying user credentials and granting them access to the application. It ensures that only authorized users can access sensitive information. The User Activity Diagram is a flow where the user inputs their data into the system to access the application and its features. The diagram outlines the steps involved in registering user data and provides a clear visual representation of the process. The Patient Activity Diagram is a flow where the system administrator can input patient referral data into the system. This data can be accessed by users who need to view patient information. The diagram outlines the steps involved in inputting patient data, ensuring that the data is accurately recorded and easy to access.

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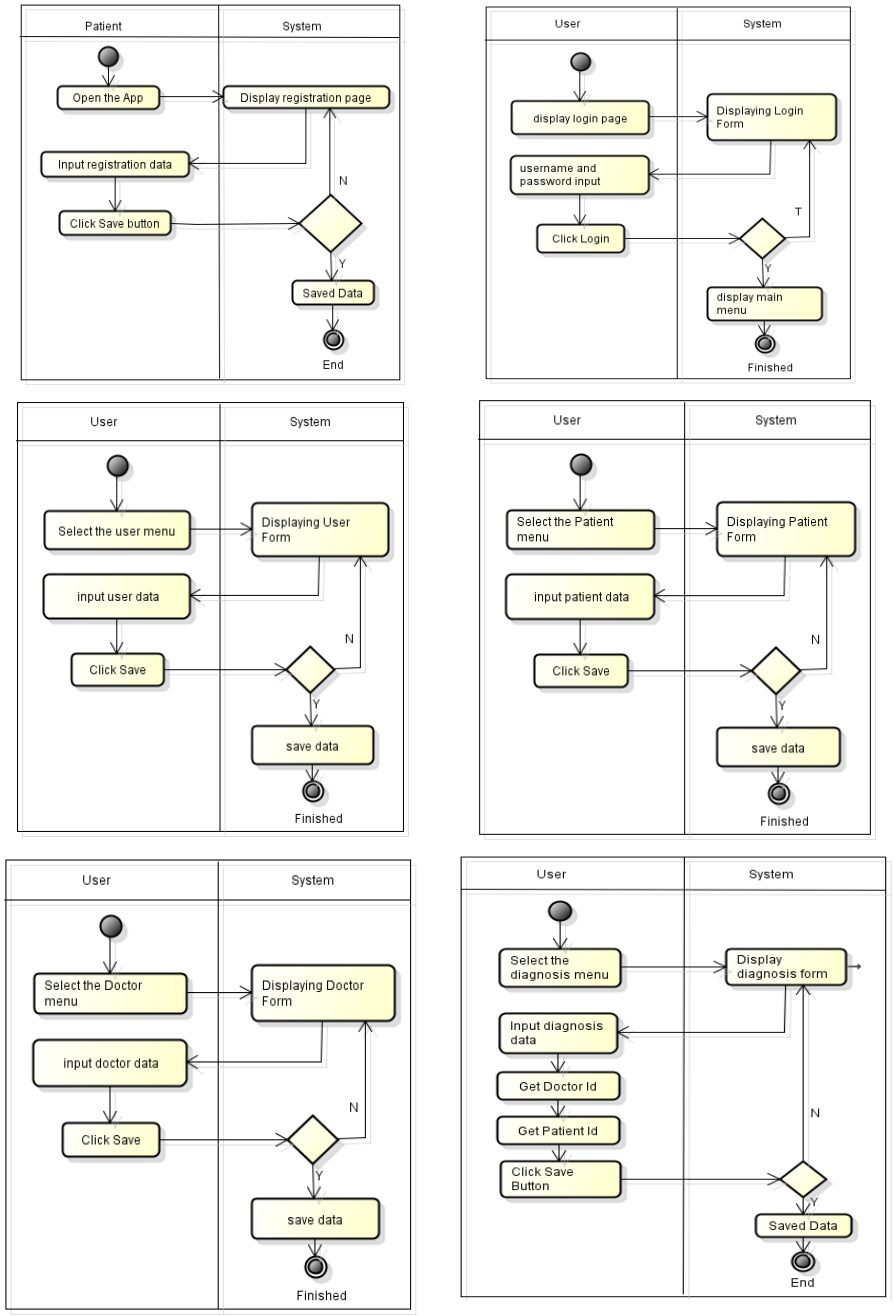

Figure 2. Activity diagram of proposed system

Similarly, the Doctor's Activity Diagram is a flow where the system administrator can input doctor data into the system. This data can be accessed by users who need to view doctor information. The diagram outlines the steps involved in inputting doctor data, ensuring that the data is accurately recorded and easy to access. The Diagnostic Activity Diagram is a flow where the system administrator can input diagnostic data into the system. This data can be accessed by users who need to view diagnostic information. The diagram outlines the steps involved in inputting diagnostic data, ensuring that the data is accurately recorded and easy to access. The Referral Patient Activity Diagram is a flow where the system administrator can input referral patient data into the system. This data can be accessed by users who need to view referral patient information. The diagram outlines the steps involved in inputting referral patient data, ensuring that the data is accurately recorded and easy to access. Finally, the Logout Activity Diagram is the exit Activity diagram that outlines the steps involved in safely logging out of the application when a user leaves the operating system. This ensures that sensitive information is protected from unauthorized access. Figure 2 is activity diagram of proposed system.

3.3. Sequence Diagrams

The Registration Sequence diagrams represent the process of storing patient registration data to the database. This sequence diagram provides a visual representation of the steps involved in registering a new patient, including the data input and storage process. It is a critical component of the patient referral information system, as it enables hospitals to manage patient information efficiently and effectively. The Login Sequence diagrams illustrate the login process that users must follow to access the application. The login process ensures that only authorized users can enter the application system. The user data has been registered into the system, allowing the application to verify their credentials and grant them access. The Patient Sequence diagram represents the process of storing patient data into the database. This sequence diagram displays the steps involved in adding new patient data to the system, such as inputting patient demographics and medical history. This process is essential for maintaining accurate and up-to-date patient information within the referral system.

The Doctor Sequence diagram represents the process of storing doctor data into the database. This sequence diagram displays the steps involved in adding new doctor data to the system, such as their contact information and areas of expertise. This process is critical for ensuring that the system can accurately match patients with the most appropriate doctor for their needs. The User Sequence diagram represents the process of storing user data to the database. This sequence diagram displays the steps involved in adding new user data to the system, such as their contact information and access permissions. This process is crucial for managing

the system's user accounts and ensuring that only authorized users can access sensitive information. The Diagnosis Sequence diagrams illustrate the process of storing diagnostic data into the database. This sequence diagram displays the steps involved in adding new diagnostic data to the system, such as lab results and medical imaging. This process is critical for ensuring that doctors have access to accurate and up-to-date patient data to make informed decisions regarding patient care. The Patient referral Sequence diagrams illustrate the process of storing patient referral data into the database. This sequence diagram displays the steps involved in adding new patient referral data to the system, such as the referring doctor's information and the patient's medical history. This process is crucial for managing the patient referral process and ensuring that hospitals have access to accurate patient data to provide the most effective care. Some of qequence diagram of proposed system, as shown in Figure 3 and 4.

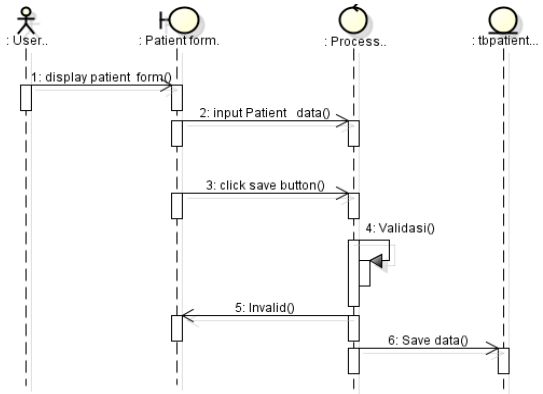

Figure 3. Patient Sequence diagram

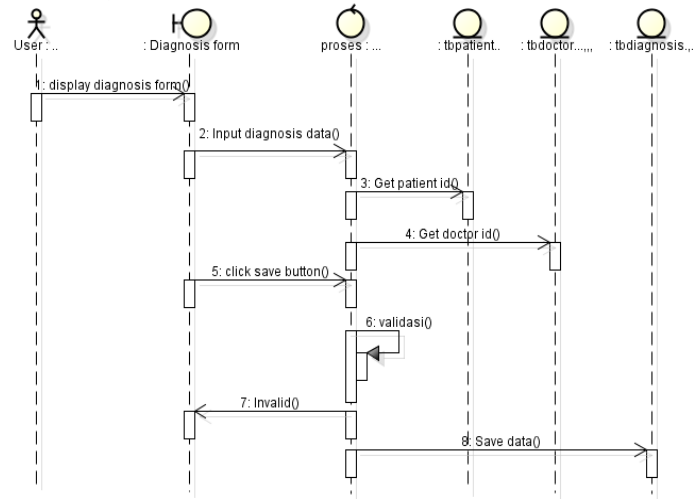

Figure 4. Diagnosis Sequence diagrams

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3.4 Class Diagrams

Based on the above activities, it is necessary to design data structures and class diagrams on the system. Figure 5 Below is a class diagram design consisting of various classes, including user data, patient data, doctoral data, diagnostic data, and patient reference data [20], [24].

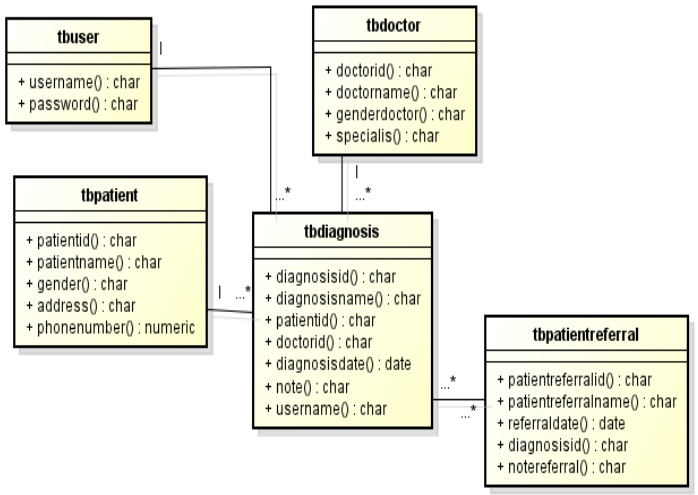

Figure 5. Class Diagrams designed system

3.5 Interface Design

The Interface Design is a crucial aspect of the patient referral information system, as it serves as an interface for users to operate the system based on their respective access rights. This includes various components such as the Main Menu Page, Registration Form interface Design, Admin Login Page, Patient Data Input Interface Design, Doctor Data Input Interface Design, User Data Input Interface Design, Diagnosis Data Input Interface Design, Referral Patient Data Input Interface Design, and Report interface.

The Registration Form Interface Design provides a patient data input form that allows patients to input their information for the first time, which is recorded in the patient referral data. The Admin Login Page is used to process system data and requires appropriate username and password input to access the database. The Patient Data Input Interface Design is used to input patient referral data into the database. The Doctor Data Input Interface Design is used to store the data of

doctors who provide references to the database. The User Data Input Interface Design is used to store user data in the database. The Diagnosis Data Input Interface Design enables doctors to input the results of their diagnosis, which will be stored in the database. Hospitals can access the diagnosis results for referral patients by referring to the database. The Referral Patient Data Input Interface Design is used to input data on patients referred to the hospital by doctors. This data is stored in the database, allowing hospitals to access referral patient data.

Finally, the Report interface exhibits the patient referral data as a record of all referral patients stored in the database. This feature is particularly useful for tracking and managing the referral process. Overall, the Interface Design plays a crucial role in ensuring that the patient referral information system operates efficiently and effectively. By incorporating these various components, the system can handle a range of tasks and users with varying levels of access. Some of interface of proposed system are as shown in Figure 6 and 7.

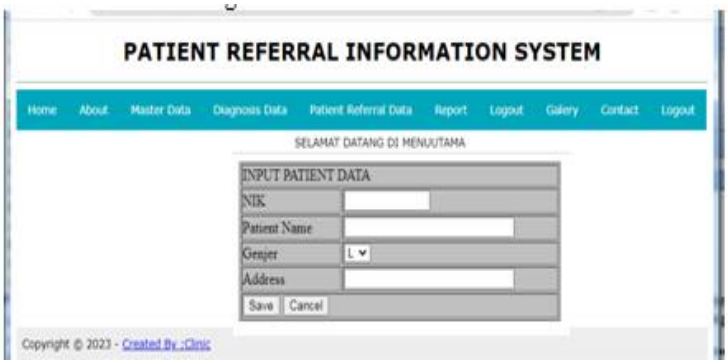

Figure 6. Patient data input interface.

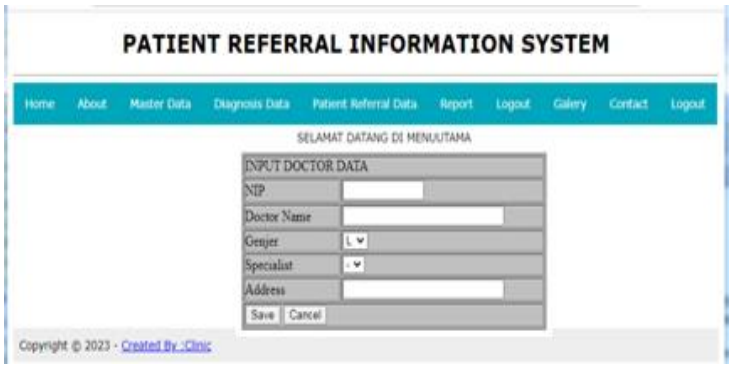

Figure 7. Doctor data input display interface

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3.6 System Testing

In BlackBox Testing, a method that involves testing the system using requirements that are opposite or contrary to those available is employed. The goal is to ensure that the system can identify and resolve input errors, as users can only input data through the interface layout. The testing process involves a range of tests, which are performed to identify and isolate potential errors, including function errors, no data in the software, errors in the user interface, problems with accessing external databases, and issues with the system's performance. Additionally, the software's essence and termination errors are evaluated during this process. Table 1 is the results from the BlackBox testing conducted on the system.

Table 1. Test Results with Blackbox Testing

Testing Scenario	Test Case	Results in Expect	Test result
Add Patient Data	patient data then, click the 'Button' add patient.	Patient Data Added Successfully	Corresponding
Delete Patient Data	the patient you want to delete then, click on the 'Delete' button	Patient Data Deleted Successfully	Corresponding
Patient Data Update	the Patient Data that you want to update later, click the 'Update' button	Patient Data Successfully updated	Corresponding

4. CONCLUSION

The study on the design of a Patient Referral Information System using an Object-Oriented System Approach at clinics in Tangerang District concludes that the current conventional referral information system is inadequate in serving patients. To address this issue, a web-based patient referral information system was designed to provide users with quick and accurate patient data information without requiring a referral certificate from the clinic. The web-based patient referral information system effectively solved problems in the referral system's circulation and provided users with more optimal and integrated referral patient data information. The system was implemented using analytical methods and an object-oriented system design approach that was user-friendly and easy to understand.

To ensure the system's user-friendliness and effectiveness, black box testing was conducted to evaluate the system's interface implementation's functions, input, and output. This testing aimed to ensure that the designed system could be easily understood and used by users. Overall, this research provides a valuable

contribution to the healthcare information systems field and has the potential to improve the referral process at clinics in Tangerang District.

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