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Analyzing and Designing Decision Support Systems for Stroke Patient Daily Treatment

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***Abstract*—** Stroke is one of the neurological diseases that often requires complex management and treatment. Making the right decisions in diagnosing and treating stroke patients can have a significant impact on the recovery process and the quality of life for patients. To assist healthcare professionals and patients in making more informed decisions, this research has developed the "StrokeCare Navigator," a web-based Decision Support System (DSS) that utilizes the Decision Tree C4.5 algorithm. This system allows users, including healthcare professionals and patients, to input symptoms and patient medical information, providing an initial diagnosis of the type and severity of the stroke. Additionally, the system offers personalized treatment guidelines, treatment recommendations, and online patient monitoring services. The Decision Tree C4.5 model used in this system was developed through training with relevant patient data. Evaluation results indicate that the system can provide accurate and beneficial recommendations for healthcare professionals and patients. Testing and patient monitoring in clinical practice also demonstrate the potential to enhance stroke patient care. Therefore, StrokeCare Navigator is expected to be a valuable tool in stroke patient management and treatment, ultimately improving the prospects of patient recovery and providing better guidance for healthcare professionals. This research also provides deeper insights into the implementation of the Decision Tree C4.5 algorithm in the context of Decision Support Systems (DSS) in the medical field.

***Keywords*—** Stroke disease, Decision Support System, Daily treatment, e-Health, System design.

I. INTRODUCTION

The advancement of human capabilities enables the creation of technological solutions to address various problems. The development of information technology has accelerated and improved the accuracy of decision-making processes. The use of computers is not only limited to data processing and information presentation but has also evolved into the ability to provide various options as part of decision support systems. This phenomenon is due to advancements in hardware development, followed by software evolution, and the ability to integrate various decision-making techniques into a single entity (Andri 2022). In the era of the 5.0 industrial revolution, the medical sector is faced with demands to continuously learn new skills and adapt quickly to emerging health challenges (Banik et al. 2022). Medical professionals are required to keep pace with the times by using methods, approaches, techniques, and skills relevant to current health issues. Individuals pursuing careers in the medical field are expected to have abilities that align with the advancements in time, in response to the demands of medical and technological developments. Workforce capabilities in the medical field are crucial in facing the dynamics of such changes (Karim et al. 2020).

Based on data from the Ministry of (Kementrian Kesehatan 2023) SATUSEHAT program on October 30, 2023, it shows that Indonesia experiences morbidity or unhealthy conditions in the Indonesian population. There are 10 diseases including Essential Hypertension (primary) with 68,620 patients (7.95%), Diabetes Mellitus not dependent on insulin with 57,010 patients (6.60%), Chronic Ischemic Heart Disease with 38,088 patients (4.41%), Hypertensive Heart Disease with 33,326 patients (3.86%), Dyspepsia with 28,170 patients (3.26%), Acute upper respiratory infections in multiple and unspecified places with 28,177 patients (3.26%), Dorsalgia with 27,888 patients (3.23%), diseases of the dental pulp and periapical tissues with 25,183 patients (2.92%), Congestive Heart Failure with 23,034 patients (2.67%) (Singh 2019).

Hypertension is a major triggering factor for stroke, both hemorrhagic and ischemic strokes (Pagano 2021). Several factors can influence the occurrence of stroke, including age, gender, genetic factors, race, hypertension, hypercholesterolemia, diabetes mellitus, smoking, atherosclerosis, heart disease, obesity, alcohol consumption, stress, socioeconomic conditions, unhealthy eating patterns, lack of physical activity, and the use of contraceptive drugs (Bhuiyan et al. 2021). However, of these factors, hypertension is a significant factor in stroke occurrence. Meanwhile, lipid levels and smoking habits have no significant relationship with stroke occurrence

(Puspitasari 2020). Medical risk factors in- volve conditions such as high blood pressure, high cholesterol, diabetes, and a per- sonal or family history of stroke or heart attack. 70% of stroke cases occur in low and middle-income countries, which also account for 87% of deaths and years lived with disability related to stroke (Postolache 2021). So, one of the triggers for stroke disease is when someone experiences Hypertension, Diabetes Mellitus, and Chronic Ischemic Heart Disease (Ramadhan 2022).

Despite those tremendous problems faces in health condition among society, few information system solutions address this problem. There were only a few researches designed a comprehensive application to prepare for patient care (Citra, Sriyasa, and Santoso 2024). Many of them were supporting the application for doctors.

This study can take a role to become a digital healthcare treatment to improve the quality of life of the community (Richter et al. 2021). This research developed a system by using primary data collection from stroke patients. The results of the research predicted an innovation in healthcare industry, especially elderly people who suffer from stroke disease. This research is also rooted in the experience of relatives and family members of researchers who have suffered from stroke. An event that changed the dynamics of the family, providing a strong impetus to carry out research related to stroke management (Zhang et al. 2021).

From the problem statement that had been presented, a decision support system is needed for stroke patient care. The design of a web-based application was chosen to make it easier to care for stroke patients through mobile phones or laptops. This study aims to develop "Stroke Care Navigator," a web-based Decision Support System. The system is designed to provide personalized guidance in decision making, which can assist patients in daily clinical practice and improve patients' and families' understanding of stroke. The expected result of the study is to be able to become personal treatment application. With this application, it can help patients to better manage and improve their own health conditions. The first step needed is analysis. This step addressed to find an application design that accommodates user needs comprehensively. Furthermore, the design stage is carried out by applying the algorithm that is the main idea of decision support system. The author has tested the feasibility of the application and how it can be used well in society.

II. Literatur Review

A. Design of Decision Support System

According to (Sutton et al. 2020), design is a process of creating and designing a new system. Design is a step in the process of creating new specifications designed to solve problems based on analysis recommendations, with the aim of creating a new system that will be integrated into existing or non-existing systems.

According to (Natsir, F, Sihombing 2022), a Decision Support System (DSS) is a computer-based information system that is flexible, interactive, and adaptable, developed to support solutions for specific unstructured management problems. A Decision Support System (DSS) is a tool designed to assist decision-makers by providing relevant processed information, allowing them to make decisions more efficiently and accurately. Its function is to aid decision-makers in addressing com- plex, especially unstructured, problems by presenting various information that can be used as considerations for selecting the best solution (Duwiyanti 2019).

B. System Development Tools

The development tool used is a unified modeling language to visualize elements in the object-oriented analysis and design process (Sandfreni, Ulum, and Azizah 2021). its elements are defined as follows:

1. Use Case Diagram: Use case is a technique in software engineering used to define, describe, and analyze interactions between the developed software system and users or other external entities. Use cases identify various actions or scenarios involving users or ex- ternal actors in achieving specific goals with the system.
2. Activity Diagram: Activity Diagram is a type of diagram used in the Unified Modeling Language (UML) to depict activities, processes, or workflows within a system, whether it's a software system or a business system. Activity diagrams aid in modeling operational logic or workflow involving various actions or activities.
3. Sequence Diagram: Sequence Diagram is one of the diagram types in the Unified Modeling Language (UML) used to depict interactions between objects within a software system. This diagram highlights how objects communicate with each other in various scenarios and specific time sequences (Sitorus and Sakban 2021).
4. Class Diagram: Class Diagram is a type of diagram in the Unified Modeling Language (UML) used to depict the structure and relationships between classes within a software system. This diagram provides a static view of the class elements within the system and aids in understanding and documenting the system's structure.
5. Language Programming: In this research, the programming language used is the Laravel framework. Laravel was chosen as the primary tool for system development due to its robust capabilities and large community support. By using Laravel, researchers can implement complex features more efficiently and effectively (Putra 2018). The use of this framework also allows researchers to expedite the overall system development process. The excellence and openness of Laravel ensure that this research can produce optimal and easily learnable solutions.

III. Methodology and Diagrams

This research utilizes the Rapid Application Development (RAD) method. This method assists in the

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progression of system development. The stages involved are as follows:

1. Requirements Planning: This stage entails problem identification and data collection from users or relevant parties to identify the ultimate goals or information needs desired from the system. The aim is to understand the ultimate purpose or end goal desired by users or stake- holders.
2. System Design: In this stage of system design, the creation of the user interface and user experience is based on user needs analysis. The system design will go through prototyping, testing, and refinement, where the user interface and user experience will iteratively change based on user needs analysis.
3. Development Process: Conducting the coding stage agreed upon in the previous step (Kashani 2021). In this stage, there- searcher develops programming applications:
   - PHP framework Laravel, HTML, CSS, and JavaScript in the coding stage, the researcher uses the Laravel programming language, which is based on the Model-View-Controller (MVC) concept, where:
   - The Model represents the application logic responsible for accessing and manipulating data. The Model interacts with the database to retrieve or store necessary information. In Laravel, the model represents tables in the database.
   - The Route is responsible for defining the URL addresses that will be directed to the controller.
4. Implementation: In this stage, the researcher implements the design of a system that has been approved in the previous stages. Before the system is hosted, it undergoes a testing process to detect any errors in the coding (Adhy 2021).

The enhanced model is then examined by evaluating each variable. Seeking the relationship and the correspondent of each dependent and independent variable. Afterwards, authors described the characteristics of each variable. The next step is finding the significant effect of the relationship in in the variables. The first data analysis assesses the descriptive statistics.

A. Use Case Diagram

Use case diagram created based on the critical user that should be implemented. A use case is a functional description component in a system. So that consumers and makers know each other and understand the flow of the system to be created. The diagram captures all of the activities that can be executed by the user, the activities created can be seen in Figure 1. From the user perspective, the application will have several features related to clinical pathway of the stroke patient treatment steps.

The use case diagram in this system design describes the users who will access the system. The system design in the use case stage provides an overview of several functions and features developed by researchers. The access rights applied in the application make application development easier. The features in the system developed from the use case diagram are also features that are easy to access by young or elderly people, as users of this stroke care system.

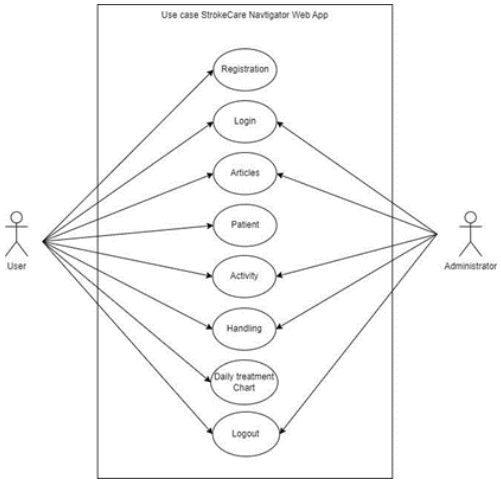

Figure 1. Use Case Stroke Care Navigator Web App

The designed application has two actors consisting of an admin and a user, where the user refers to someone who manages patients suffering from stroke, and the admin is someone who manages the system.

B. Activity Diagram

The process sequence of a system is depicted vertically. Activity diagram is a development of Use Case which has an activity flow. The flow or activity can be a sequence of menus or business processes contained in the system (Siregar and Susanto 2022). Activity diagrams do not explain actor behavior. It can be interpreted that in making activity diagrams it can only be used to describe the workflow or system activity. Figure 2. shows the flow of activity diagram for adding patient process.

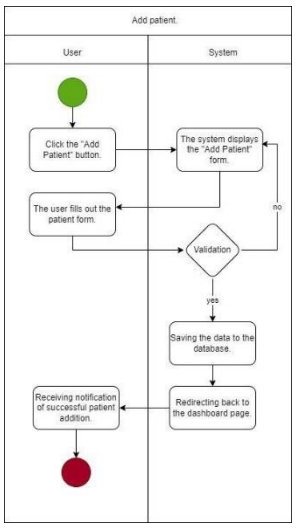

Figure 2. Activity Diagram Add Patient

Based on the analysis result, the application should have some features which users can add patient data to the Stroke Care Navigator system. Patient data entry marks the initial step in this system, as users input triggers and complications experienced by stroke patients.

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The next step was creating the activity diagram for daily treatment, as seen in Figure 3.

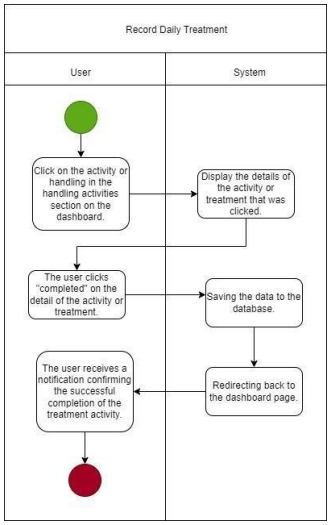

Figure 3. Activity Diagram Record Daily Treatment

Users can record daily treatments by clicking "completed" on the detailed treatment activity. Proposed Activity Diagram Record Daily Treatment built to provide comprehensive guidance for patients so that the patient's daily life can be monitored.

C. Sequence Diagram

Sequence diagram or sequence diagram is a diagram used to explain and display the interaction between objects in a system in detail. In addition, the sequence diagram will also display the messages or commands sent, along with the time of their execution. The use of sequence diagrams is to show how objects can collaborate in several behaviors.2

Objects related to the running of the operation process are usually sorted from left to right. Figure 4. shows that users can add a maximum of one patient to the system with predefined validation.

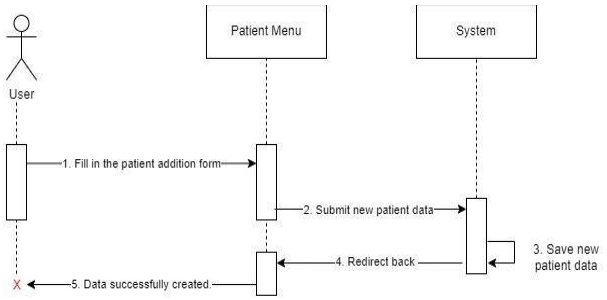

Figure 4. Sequence Diagram Add Patient

The main purpose of creating a sequence diagram is to find out the sequence of events that can produce the desired output. In addition, the purpose of this sequence diagram is like the activity diagram, such as describing the workflow of an activity, and can describe the data flow in more detail, including data or behavior received or sent. Figure 5. shows that users can log their treatment when they have completed the recommended handling activities in the system.

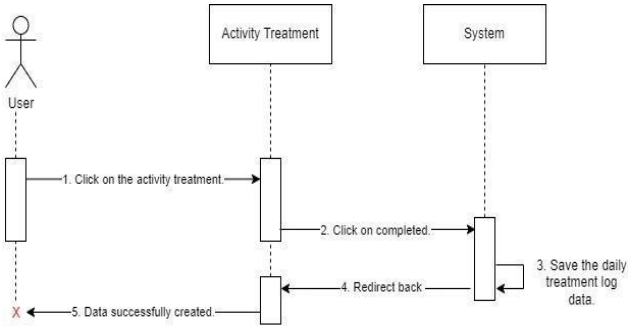

Figure 5. Sequence Diagram Activity Treatment

Sequence diagrams can be used to describe a series of steps taken in response to an event to produce a specific output. Sequence diagrams are related and closely related to use case diagrams, where one use case diagram will be one sequence diagram.

D. Class Diagram

Behavior diagrams describe the dynamic or behavioral aspects of a system. While structure diagrams describe the static or structural aspects of the software system to be developed. One of the structure diagrams that describes the most basic object modeling is the class diagram. Quoted from IBM, a class diagram is a diagram that shows the structure of a system starting from the system class, attributes, methods, and relationships between objects. Depending on the complexity of the system, this diagram can be used to model the entire system or just a few components. Class diagrams can help understand system requirements and design details. This diagram is one of the UML structure diagrams commonly used to document software architecture or structure. Figure 6. shows a class diagram consisting of several related tables, including users, treatment, activity category, treatment log, handling category, patients, activities, article category, handling, complications, articles, and triggers.

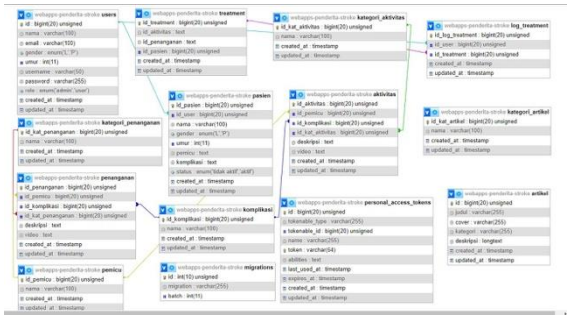

Figure 6. Class Diagram Stroke Care Navigator

The users table represents registered users, the treatment table is a storage for treatment data based on patient IDs, the activity category table stores activity categories related to the activities table, the activities table stores activity data, the patients table holds data of stroke

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patients, which is related to activities and handling, the handling category table stores handling category data related to the handling table, the handling table stores handling data, the article category table stores article category data related to the articles table, the articles table is a storage for article data, the complications table is a storage for complication data, and the triggers table is a storage for trigger data.

IV. The Result and Discussion

E. Design User Interface and User Experience

A good and attractive user interface will give a good first impression to system users, because of this important role, a UI designer must be careful in designing the user interface. Figure 7. shows the patient addition form filled out by the user. This form is de- signed to collect important information about the patient to be added to the system. The requested information includes the patient's full name, gender, and age.

Figure 7. Add Patient Page

Additionally, there are fields to record triggers and complications related to the patient's health condition. Filling out this information helps build a comprehensive patient profile, which can then be used to formulate appropriate and customized treatment recommendations. This form provides a structured framework for collecting patient data, ensuring that relevant information can be accessed and managed efficiently by the system. Figure 8. shows the activities page, which provides treatment recommendations that the patient should follow after the user fills out triggers and complications in the patient's profile.

The result of implementation of Activity treatment page was displayed in Figure 8. These activity recommendations are dynamic and depend on the triggers and complications experienced by the patient. Some activities may be accompanied by videos explaining how to perform them, while others are supported only by images or written instructions.

The purpose of this activities page is to provide clear and guided instructions to the patient in undergoing the recommended treatment, thereby helping to improve the effectiveness of the provided care and optimize the patient's recovery.

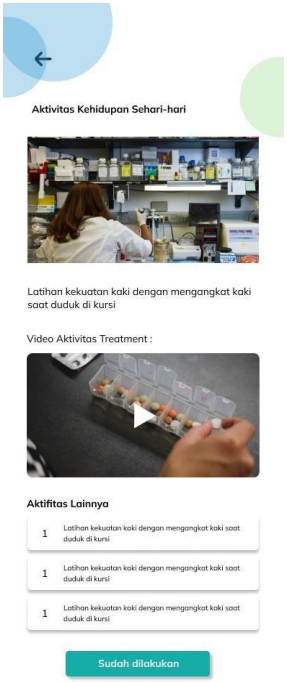

Figure 8. Activity Treatment Page

The system displayed features activity treatment which contained some videos on how to conduct clear motion to increase patient's fitness. All the tutorials and videos shown in the system were performed by health workers who are experts in their fields. Figure 9 shows the activity treatment for stroke patients which can enhance hands and legs movement.

Figure 9. Activity treatment features

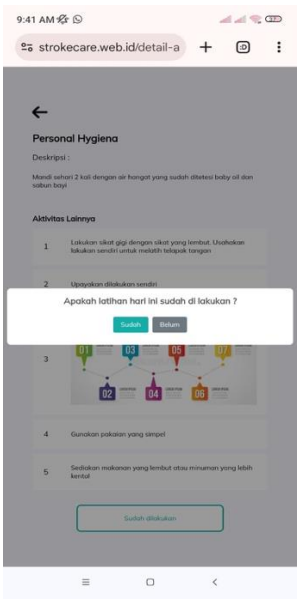

Figure 10. Popup features when user input some activities

Daily activities and treatment of stroke patients will be recorded by the system. The patient can input their daily treatment through the system, then the system will record and give some suggestions to the patient. Activity recording features shown in Figure 10. The popup gives question to the user weather the user would save and record the data or not.

After users input and record each daily treatment, the system will also display progress diagram. The progress diagram is shown in Figure 11. The progress activities diagram can be seen daily or each week. It depends on patient desire. A systematic storage system has been implemented, which can guide the stroke patient to monitor their health. The data that has been stored in the system can be displayed anytime the patient needed it.

Figure 11. Progress activities for each week

The result of the system implementation shows a simple and easy to use design concept. This concept was applied due to the target users. Target users of this system was young and elderly people. Young people can come from the patient's family members. Prior research which has been discussed in the literature review also presenting the health system, but few of them addressing in stroke as the disease that causes the most deaths in Indonesia

Stroke Care Navigator was developed as a Decision Support System for stroke patient care. This system was designed to provide personalized guidance, improve patient understanding of stroke, and facilitate clinicians in delivering more effective care. The use of the Stroke Care Navigator can enhance the accuracy of stroke prognosis and provide treatment tailored to patients' symptoms, while providing better understanding to patients about their condition. The system implements a novel application of the Decision Tree C4.5 algorithm to be used in the Decision Support System. The implementation of algorithms can improve system performance. The finding was helpful for the development of the health system

V. CONCLUSION

Future development of the system can develop more features which cover other types of strokes and broader risk factors. Adding interactive features, such as discussion forums or online consultations, can enhance the interaction between patients, clinicians, and the system. Another alternate feature was option for chronic conditions patients. This expansion will also further enhance system utility and its impact to healthcare system development.

Other further development could consider Internet of Things (IoT) devices for real-time monitoring of patient's symptom and growth would be better development of the disciplines. Embedding Artificial intelligence by learning recovery patterns would also enhance personalization and

provide better effects to users. This will provide a more valuable and supportive experience for users. In addition to the website version, developing a mobile application for the "Stroke Care Navigator" could also be the next step. This will enable easier and efficient access for users who use mobile devices. To increase the system's reliability, researchers could gather feedback from both patients and healthcare providers. Several things can still be developed that will support optimal utilization to provide a greater effect on the healthcare industry.

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