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Forecasting Survival Rates Post-Gastrointestinal Surgery: Integrating The New Japanese Association of Acute Medicine (JAAM Score) and Neural Network Classification

Ayu Nabila Kusuma Pradana[1], Aprinaldi Jasa Mantau [2], Guo Jiea[1], Shuo Zhang[1], Masaharu Murata[1] ,Sayako Nahara[1], Tomohiko Akahoshia[1]*

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ABSTRACT

Following gastrointestinal surgery, the incidence of disseminated intravascular coagulation (DIC) has a bad prognosis. Consequently, it is essential to identify the variables that can predict the prognosis of DIC. This study will examine the factors that may affect the outcome of DIC in patients who have had gastrointestinal surgery. From 2003 to 2021, 81 patients were admitted to the intensive care unit at Kyushu University Hospital following gastrointestinal surgery. DIC scores were computed using the new Japanese Association of Acute Medicine (JAAM) score from before and after surgery. Comparisons will be made between DIC values and The Sequential Organ Failure Assessment (SOFA) score, platelet count, lactate level, and biochemical markers. This study utilized machine learning techniques to determine the prognosis of DIC following gastrointestinal surgery. After gastrointestinal

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1. INTRODUCTION

According to The Third International Consensus Definitions for Sepsis and Septic Shock, sepsis is a life-threatening condition caused by impaired regulation of the host's response to infection [1]. Sepsis has still become one of the leading causes of mortality in the world [2]. Sepsis can be caused by a spontaneous perforation or as a complication after abdominal surgery. Sepsis after abdominal surgery mainly occurs in patients with colorectal perforation-associated peritonitis and usually has a poor prognosis [3].

A recent nationwide survey in Japan reported that approximately one-third of patients exhibited shock in patients with sepsis in the intensive care unit, and more than half exhibited DIC. These two significant factors can lead to poor outcomes in sepsis [4].

DIC associated with sepsis is considered a syndrome that should be diagnosed and treated early. Diagnostic criteria play a key role in making an accurate diagnosis and starting therapy early to improve prognosis. There are several diagnostic criteria for DIC. Each criterion has its strengths and weaknesses [5]. The Ministry of Health and Welfare (JMHW) Japan developed scoring systems to diagnose DIC in 1987. In 2001, the International Society on Thrombosis and Haemostasis (ISTH) initiated the first diagnostic criteria for overt DIC. In 2006, the Japanese Association for Acute Medicine (JAAM) proposed new diagnostic criteria to facilitate early identification and intervention [6][7]. Among other diagnostic criteria, the Japanese Association for Acute Medicine criteria (JAAM-DIC) have consistently shown higher sensitivity and predictive accuracy for mortality compared to other DIC criteria [8].

In recent years, there has been growing interest in applying Machine Learning in health services research. Advanced machine-learning models can fit high-order relationships between covariates and outcomes, and therefore, they excel in analyzing complex signals in data-rich environments and can improve clinical decision-making[9]. This study used the JAAM-DIC criteria, SOFA score, and other biochemical parameters and used the machine learning tool to predict the survival rate after gastrointestinal surgery. The machine learning approach is used here to simplify and assist doctors in predicting the prognosis or survival rate of a patient so that the next appropriate treatment can be known.

The paper is organized as follows: Section 2 will explain some literature, basic knowledge, and tools that we used in this research. In Section 3, we present our research methodology and necessary background for the following parts and the evaluation methods. Section 4 describes the result of the experiment and also the analysis and conclusions are drawn in Section 5.

A scoring system for disseminated intravascular coagulation (DIC) was established by the Japanese Association for Acute Medicine.

Table 1 A scoring system for disseminated intravascular coagulation (DIC) was established by the Japanese Association for Acute Medicine.

	Score
Systemic inflammatory response syndrome criteria	
· ≥3	1
· 0-2	0
Platelet counts (109/L)	
· <80 or more than 50% decrease within 24 hours	3
· ≥ 80 and < 120 or more than 30% decrease within 24 hours	1
· ≥ 120	0

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· Prothrombin time (value of patient/normal value)	
· ≥1.2	1
· <1.2	0
Fibrin / Fibrinogen degradation products (mg/L)	
· ≥25	3
· ≥10 and <25	1
· <10	0
The diagnosis of DIC is made if the score is 4 or more	
Criteria for Systemic Inflammatory Response Syndrome	
• Temperature >38°C or <36°C	
• Heart rate >90 beats/min	
• Respiratory rate >20 breaths /min or PaCO2	
• White cell blood counts >12,000/mm3, <4000cells?mm3, or 10% immature (band) forms	

1.1. The New Japanese Association for Acute Medicine (JAAM) DIC criteria

The Japanese Association for Acute Medicine (JAAM) created the DIC diagnostic criteria in 2006 because the Japanese Ministry of Health and Welfare's (JMHW) DIC diagnostic criteria were often too late for emergency medicine and surgery cases [5]. The DIC diagnosis was performed based on the JAAM DIC diagnosis criteria can be seen in Table 1. Patients with a total score ≥ 4 were diagnosed as having[7][10]. The Japanese Association for Acute Medicine (JAAMDIC) criteria consistently showed higher sensitivity and predictive accuracy for mortality than other DIC criteria[4]. Fibrinogen was initially included in The JAAM criteria for DIC diagnosis at ≥5 points, but fibrinogen could not be shown to have diagnostic significance in actual application. Fibrinogen was eliminated from the criteria for DIC diagnosis at ≥4 points[5]. The Japanese Clinical Practice Guidelines for the Management of Sepsis and Septic Shock (J-SSCG 2016) build on clinical evidence recommending the use of the JAAM-DIC criteria to decide when to intervene. The JAAM-DIC diagnostic criteria are helpful and are still considered to be the standard of practice in Japan[11].

1.2. Machine Learning

Machine Learning (ML) has evolved over the last few decades from a hobby of a few computer enthusiasts who wanted to see if computers could learn to play games to an independent research discipline. ML has not only provided the necessary foundation for statistical-computational principles of learning procedures but has also developed many algorithms that are now widely used. We can say that Machine learning is a paradigm that refers to improving future performance by learning from existing experience (in this case, historical data)[12]. At this time, many fields apply machine learning it, not only limited to computer-related fields but also many other fields such as business, medicine, industry, education, natural science, agronomy, astronomy, and many more.

Machine Learning was a phenomenal result when Computer Science and Statistics merged. Computer Science focuses on building machines that solve a specific problem and identifying whether the problem can be solved. The main approaches that are fundamentally used in Statistics are data inference, hypothesis modeling, and measuring the reliability of conclusions.

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1.3. Popular Machine Learning Algorithm

Machine learning is used in many sectors because a lot of studies have been done on it. Various researchers have contributed to ML and introduced many algorithms and techniques. Following are the famous and most commonly used machine learning algorithms along with their use cases and applications[13]:

1) Linear Regression algorithm
2) Logistic Regression algorithm
3) Decision Tree algorithm
4) Support Vector Machine (SVM) algorithm
5) Naïve Bayes algorithm
6) k-Nearest Neighbor algorithm • K-means Clustering algorithm

1.4. Weka

Weka is one of the machine learning tools that are widely used today, which is an open-source tool with a graphical user interface[14]. WEKA was developed by Waikato University, and now Weka is widely used in science, industry, and education. It includes a variety of built-in tools for common machine learning tasks as well as easy access to many toolboxes. Some of the advantages of this tool are that the algorithm is simple to understand, and Weka is also beneficial for students because it is free. It offers instruction through online courses, multi-platform compatibility, and a straightforward interface. WEKA supports several standard data mining and data processing tasks, including data preprocessing, clustering, classification, regression, visualization, and feature selection[15].

2. METHODS

Machine Learning is used to learn the pattern and generate a classification model. In pattern recognition applications, neural networks are a standard Machine Learning method, and their performance has been proven. Neural Networks were employed in some pattern recognition studies. Some research about pattern recognition applications in the Medical field uses the Neural Network approach[16][17]. The machine learning process with a neural network is depicted in **Figure 2**.

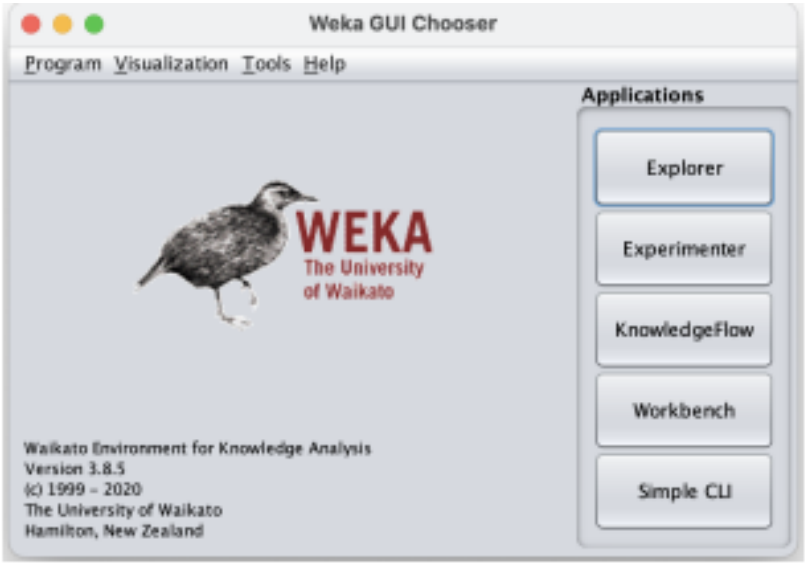


Figure 1. Weka Application startup screen wek

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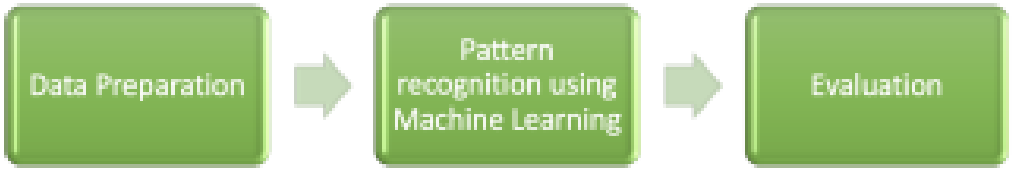


Figure 2. The flow of the machine-learning process

Testing Data Testing which totaled 25 data and Data Training 75 samples of early childhood data.

2.1. Data

All patients admitted to the Kyushu University Hospital's ICU from 2003 to 2021 were screened retrospectively. Patients were eligible for the study if they had gastrointestinal surgery and met the inclusion criteria during ICU admission: two or more signs of systemic inflammation, at least one sepsis-induced organ dysfunction, and 16 years of age or older. The exclusion criteria were patients with a SIRS score ≤1, unknown outcome, not receiving gastrointestinal surgery, and pregnancy. This study included 81 patients who met the inclusion criteria. Extensive medical records data were collected to assess for potential confounding factors. The severity of the patient's illness was evaluated using the Acute Physiology and Chronic Health Evaluation (APACHE) II score and the Sequential Organ Failure Assessment (SOFA) score used to assess organ dysfunction[10]. We calculated DIC scores using the new Japan Acute Medicine Association (JAAM) scores for presurgery and day 1, 3, and 7 postsurgery. This study was conducted under the ethical guidelines of the Declaration of Helsinki. This study was performed after approval from the ethical committee at Kyushu University.

In the data preparation step, several things must be done: Data Selection, Data Pre-processing, and Data Transformation. Data Selection is the stage to select the data related to the objective investigation, and we only consider data or attributes that might be useful for our prediction. Data Preprocessing is the stage to remove irrelevant data and validate the data. Data Transformation means transforming the selected data into appropriate forms for the following process.

2.2. Training Process

In this training step, data is divided into two groups, which are Training Data, and Testing Data. The algorithm used is 10 FOLD-CROSS VALIDATION. Cross-validation (CV) is a statistical method that can evaluate the performance of a model or algorithm where the data is separated into two subsets, namely learning process data and validation/evaluation process data.

The model or algorithm is trained by the learning subset and validated by the validation subset. Furthermore, the selection of the type of CV can be based on the size of the dataset. Usually, the K-fold CV is used because it can reduce computation time while maintaining the estimate's accuracy. The 10-fold CV is one of the recommended K-fold CVs for selecting the best model because it tends to provide less biased accuracy estimates than the usual, leave-one-out CV. In a ten-fold CV, the data is divided into ten folds of approximately equal size, so we have ten subsets of data to evaluate the performance of the model or algorithm. For each

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of the 10 data subsets, CV will use nine folds for training and one-fold for testing, as illustrated in **Figure 3**.

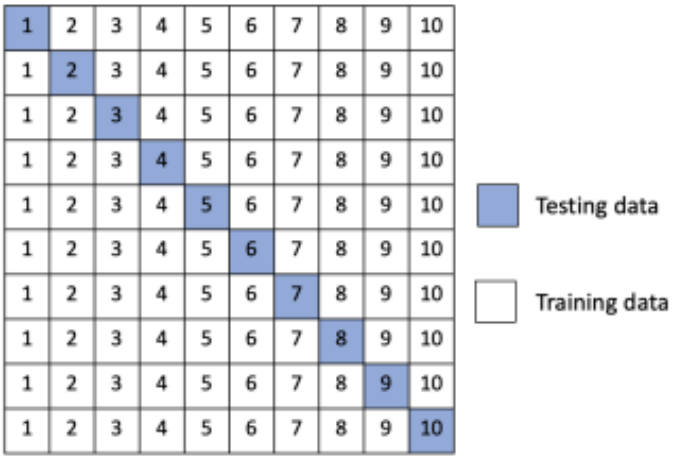


Figure 3. 10-Cross Validation scheme

2.3. Evaluation

After we train our model, we need to evaluate the performance of this model. The performance of the model is evaluated by Accuracy in Equation 1.

$$Accuracy = \frac{TP + TN}{T\,P\ +\ T\,N\ +\ F\,P\ +\ F\,N} \quad (1)$$

where :

- $T\,P$ denotes True Positive
- $T\,N$ denotes True Negative
- $F\,P$ denotes False Positive
- $F\,N$ denotes False Negative

The performance of the model will be evaluated by Mean squared error (MSE). MSE value is the average of the absolute value of the difference between an observed value of a quantity and the actual value., MSE is the average squared difference between the outputs of the models and real value. A good MSE value is close to zero

Table 2. Performance comparison among popular ML algorithms with all variables

Algorithm	Performance	
	Accuracy	MAP
Logistic Regression	85.0746 %	0.1546
Naïve Bayes	92.5373 %	0.1449
Random Forest	88.0597 %	0.0746
SVM	92.5373 %	0.0746

$$MSE\ =\ \left(\frac{1}{n}\right)\sum_{i=1}^{n}\ \ 1\ (y_i - x_i)^2 \quad (2)$$

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3. RESULTS AND DISCUSSION

Experiments were conducted on two scenarios. The first scenario is to see the performance of some of the most popular machine learning algorithms using all the variables we defined earlier. The second scenario is using the Weka tool, then we rank the existing variables and choose eight variables with the highest correlation level with the prognosis class. Furthermore, the eight variables will be used in the machine learning algorithm, and we can see the performance.

3.1. Scenario I

We used 28 variables which will then be used as input to the machine learning algorithm (including JAAM criteria, laboratory findings, and clinical parameters). The result can be seen in **Table 2.**

3.2. Scenario II

In scenario I we have 28 variables, but in scenario II, we will reduce it to only about 8 variables. The idea is to reduce the number of variables involved because doctors or practitioners can more easily input the data to be processed in machine learning applications.

To process selecting variables in our data, we need to perform variable selection. There are many variable selection methods in Weka, in this preliminary research, we use the Correlation Feature Selection. Correlation-based feature selection is a popular technique for selecting the most relevant attributes in the dataset. This Correlation is more formally referred to as Pearson's correlation coefficient in statistics. We can calculate the correlation between each attribute and the output variable and pick only those attributes with a high positive or negative correlation (near 1 or -1) while excluding those with a low correlation (value close to zero). The result from variable/attribute selection can be seen in **Figure 4**.

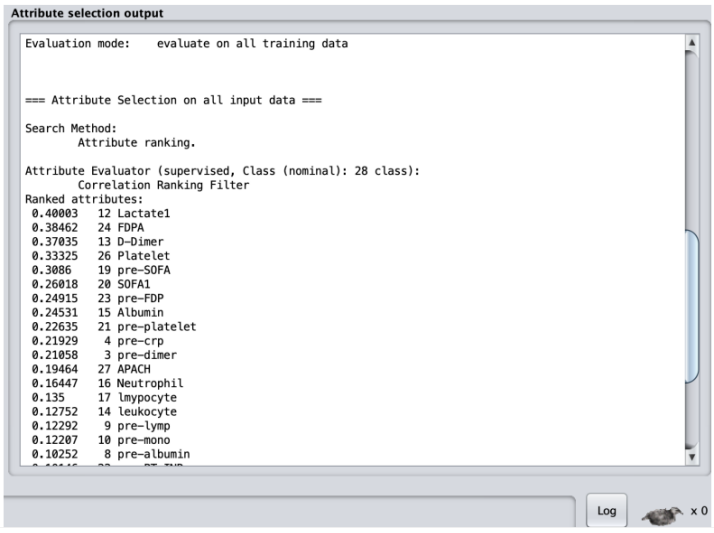


Figure 4. Variable / Attribute Selection Result

Table 3. Performance comparison among popular ML algorithms with 8 selected variables

Algorithm	Performance

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	Accuracy	MAP
Logistic Regression	85.0746 %	0.1454
Naïve Bayes	89.5522 %	0.1071
Random Forest	92.5373 %	0.1093
SVM	92.5373 %	0.0746

After we get the ranking of variables, then we need to use the top 8 variables only to be processed by the Machine Learning application. The 8 selected attributes are as follows: • Lactate day 1

1) FDP
2) D-Dimer
3) Platelet
4) pre-SOFA
5) SOFA day-1
6) pre-FDP
7) Albumin

These eight variables have the highest correlation with the patient's prognosis. FDP and D-dimer have great significance in diagnosing DIC, and they are included as essential test items in almost all DIC diagnostic criteria. A decreased platelet count has a high sensitivity for DIC diagnosis, but the specificity is low [5]. The input results showed that the lactate level on the first day and albumin also affected the patient's prognosis. Lactate level is used as an indicator of the occurrence of shock in patients. Albumin levels as one of the factors that affect the prognosis can be further analyzed.

From Table 2 and Table 3, we can see there is no significant difference. On average the accuracy of all those algorithms is around 90%. This machine learning application is reliable enough to help doctors quickly get early predictions about patients' emergency status. The use of 28 or 8 variables shows that the accuracy is not much different. This may be because, from the data we have, these 8 variables have a very close correlation with the patient's prognostic condition. However, this is still a very early analysis and requires further evidence and a larger amount of data in to better understand which variables have the most influence in determining the patient's prognosis.

4. CONCLUSION

Early Prediction of Survival Rate after Gastrointestinal Surgery Based on The New Japanese Association for Acute Medicine (JAAM Score) can be carried out by implementing a machine learning method. Average accuracy is more than 90% either with all variables or subset variables. There are still many possibilities that can be elaborated more in this research, for example exploring other sophisticated machine learning algorithms, adding more data, and investigating the effect of every variable. Also From this preliminary research, we can make a simple application in a small device to predict the Survival Rate after Gastrointestinal Surgery so we can help the surgeon or practitioner get the additional insight to take the next treatment process quickly and get early predictions about patients' emergency status.

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6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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Optimal UI/UX Design Through Lean UX Methodology: MTI Pay Case Study

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ABSTRACT

This research explores the transformative journey of MTI Pay in response to the challenges posed by technology and globalization in the competitive banking industry. The study delves into the impacts of these global shifts, emphasizing the emergence of numerous startup companies and the imperative for businesses to innovate within limited resources. In addressing this, MTI Pay introduces a super bank, leveraging advanced technology to create a personalized and easily accessible banking experience. The design process of MTI Pay employs the Lean UX method, a contemporary approach to user experience development rooted in Agile principles. This method, focusing on user-centric design, iterative development, and efficiency, aligns with the need for adaptability in a rapidly changing technological landscape. The study concludes with optimism about the positive impact of implementing Lean UX, anticipating improved user experiences and overall system enhancement. In essence, MTI Pay strategically positions itself to thrive in the evolving banking industry, with a commitment to innovation, adaptability, and user satisfaction. The research underscores the significance of such strategic approaches in navigating the complexities of modern banking within a globalized and technologically advanced era.

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1. INTRODUCTION

In a competitive world, the banking sector must confront the challenges of implementing technology to attract and facilitate users in utilizing services and provide a better experience for customers. MTI Pay is a solution that emerges within the community with the determination to transform the traditional banking model. Using advanced technology, MTI Pay aims to provide a more personalized and easily accessible banking experience, tailored to the individual needs of each customer.

In this era, the rapid development of technology and globalization is undeniable. This has brought significant changes to the way people live across the globe. One of the impacts of globalization and rapid technological advancement is the intensification of competition in the banking industry. With the evolution of technology and the economy, an increasing number of startup companies are emerging. Therefore, to survive, these new businesses must be able to produce the best products, albeit with limited resources of cost and time. To address this challenge, businesses are starting to seek ways to endure. In response, MTI Pay introduces a super bank that enables the application to overcome these obstacles.

In this era, the rapid development of technology and globalization is undeniable. This has brought significant changes to the way people live across the globe. One of the impacts of globalization and rapid technological advancement is the increasing competitiveness in the banking industry. With the evolution of technology and the economy, numerous startup companies are emerging. Therefore, to survive, these new businesses must be able to produce the best products, albeit with limited resources of cost and time. To address this challenge, businesses are starting to seek ways to endure. In response, MTI Pay introduces a super bank that enables the application to overcome these obstacles.

The design process development in the MTI Pay system uses the Lean UX method, which is a modern approach to user experience development. Based on the Agile development foundation, Lean UX has a user-centered approach that focuses on reducing unnecessary processes generated during the development cycle and enhancing user experience through multiple iterations without spending excessive time on documentation. The selection of the Lean UX method is deemed appropriate because it can improve the user experience through several iterative steps. Additionally, this method also focuses on user satisfaction with the developed application. It is expected that the implementation of this method will have a positive impact on the existing system in MTI Pay.

Here are similar studies to the research conducted previously. The goal is to ensure that this research has a comprehensive analysis and discussion, as well as to highlight the differences with previous studies. In this context, 15 previous research journals relevant to the research object are presented. Some examples of these journals include:

1. 1. Analysis and Development of User Interface and User Experience Based on Lean UX Methods in Mobile Academic Information System Applications

This study discusses the analysis and improvement of the User Interface (UI) and User Experience (UX) of the Academic Information System (SIA) Mobile application at Muhammadiyah University of Jember based on the Lean UX method. The research results indicate that after redesign and improvement based on expert design assumptions, there is a significant improvement in the UI and UX scales based on the analysis using the User Experience Questionnaire (UEQ). Although there are still aspects that can be categorized as neutral, this study successfully provides recommendations for a better UI appearance. The Lean UX method, which includes assumption declarations, Minimum Viable Product (MVP)

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creation, experiments, and feedback research proved to be effective in improving the UEQ score for the UMJ Mobile SIA application, which is a mobile-based academic information system application owned by the Muhammadiyah University of Jember.

1.2. UI/UX Design for the Latest Waste Bank Information System (SI B'stie) Kebumen Gemilang Sejahtera Using the Spiral Model Method

The paper presents the development of a prototype information system for the KGS Garbage Bank using the spiral model methodology, which encompasses planning, analysis and design, prototype construction, and system testing. The system, named SI B'STIE, is designed with a user-friendly UI/UX and caters to various users including customers, administrators, community waste bank groups, and visitors. It provides essential information about the business profile, activities, and products of the waste bank. Moreover, the system streamlines the management of data, transaction processing, and reporting for waste bank administrators, enhancing efficiency and ease of use. Black-box testing was employed to ensure the functionality of forms and menus, with results indicating that the system operates effectively. The paper also emphasizes the significance of the 3R approach in waste management and the critical role of user experience in the development of such information systems.

1.3. Implementation of Design Thinking in the Android-based UI/UX of the Banjarejo Digital Waste Bank

This article discusses the application of Design Thinking and the System Usability Scale (SUS) in the development of the Rumah Sampah Digital Banjarejo (RSDB) mobile application, an Android-based digital waste bank platform. The research outlines the Design Thinking methodology, which includes stages such as Empathize, Define, Ideate, and Prototype, and details the creation of wireframes, mockup designs, and application features. Usability testing of the RSDB application yielded a SUS score of 71.43, categorizing it as "Acceptable" with a "Grade B" and a "Good" rating, indicating that users find the application easy to understand and use effectively. The application aims to enhance efficiency, simplify transactions, and boost community participation in waste management. The article serves as a comprehensive reference for computer research on the integration of user-centered design in digital and web-based projects, emphasizing the importance of usability and user experience in application development.

1.4. Implementation of the Lean UX Method and its Positive Effects on Android-Based Educational Game Development Chemical Bond Material

This study explores the application of the Lean UX methodology in the development of an Android-based educational game focused on the topic of Chemical Bonds, aiming to enhance students' interest and achievement in understanding abstract chemistry concepts. The research methodology encompassed data collection, assumption declaration, creation of a Minimum Viable Product (MVP), experimentation, and feedback collection. The findings revealed that the educational game developed using Lean UX positively impacted students' learning achievements, particularly in the subject of Chemical Bonds. The final stage of development included an Anova test to analyze post-test data, confirming the game was free of errors or bugs. The game's implementation in two classrooms showed a positive effect on students' learning achievements, with several iterations required to ensure the game met user needs and produced the desired features. The references cited in the study cover a range of topics, including educational technology development, Android-based learning media,

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virtual laboratory needs analysis, educational games as learning tools, interactive learning model development, and user interface design and usability testing in educational applications.

1.5. Lean UX Applied PSSUQ to Evaluate Less-ON UI/UX Analysis and Design

This paper from the International Journal of Advances in Data and Information Systems explores the application of Lean UX methodology in evaluating the UI/UX design of a digital startup named Less-ON, which provides tutoring services. The research encompasses a comprehensive approach including a literature review, needs analysis, design, implementation, testing, and conclusion. The usability of the Less-ON UI/UX was assessed using the Post-study System Usability Questionnaire (PSSUQ), which measures system usefulness, information quality, interface quality, and overall satisfaction. The results indicated that the system was highly acceptable to users across all measured aspects. The study emphasizes the significance of user-centered design for the success of digital startups and was supported by The Directorate of Research Technology and Community Service (DRTPM) of the Ministry of Education and Culture of the Republic of Indonesia.

1.6. Lean UX and Design Sprint Methods in Creating and Developing Aryanna Applications

This paper explores the application of Lean UX and Design Sprint methodologies in the development of the Aryanna mobile application during an internship at PT Inovasi Realita Nusantara. It highlights the efficiency of these methods in saving time and costs in the UI/UX design process, enabling startups to compete more effectively. The development process involved stages of Think, Make, and Check, along with a Brand Overview to understand the brand's character and positioning. After two revisions, the application was well-received by 90% of users who participated in usability testing. The paper also emphasizes the importance of soft skills in the competitive business environment and discusses the differences between academic methods and real-world practices, noting that while university-taught methods are robust for research and design, a practical understanding of coding is essential for designers to effectively realize their designs.

1.7. Application of the Lean UX Method in Web-Based E-Learning Application Development at SMAS – AL – Fityan

This paper presents the development of a web-based e-learning application tailored for a high school, specifically SMAIT Al-Fityan School Medan, using the Lean UX method. The development process was driven by the urgent need for an effective online learning platform due to the COVID-19 pandemic. The researchers conducted a literature review, stated assumptions, and built a Minimum Viable Product (MVP). They identified essential functional requirements and evaluated the system's usability with the Software Usability Measurement Inventory (SUMI). The e-learning system was found to be efficient and successful in facilitating the educational process between teachers and students. The paper concludes with suggestions for future enhancements, including the addition of new features and the development of a mobile application, and provides a bibliography of sources used.

1.8. Career Consultation Mobile Application UI Development Using Lean UX Method

This study, published in Jurnal Ilmiah Teknologi dan Komputer Vol. 3, No. 1 April 2022, investigates the usability of an online career consultation website using a standardized

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questionnaire and identifies shortcomings in dependability and novelty. In response to survey results, the authors developed a mobile application prototype named "Konsul Aja," consisting of 14 pages designed based on user feedback and needs. The research methodology encompassed data collection, reliability and validity testing, MVP wireframe and prototype creation, feedback and research, experimentation, and new design development, with a focus on Lean UX, user interface (UI), user experience (UX), human-computer interaction, and questionnaires for UX evaluation. The study highlights the importance of UI and UX in the success of mobile applications, especially considering the rising global smartphone usage and the variety of mobile app functions.

1.9. Career Consultation Mobile Application UI Development Using Lean UX Method

This paper presents a study on the design and development of a prototype for insurance and Last Wish features within the Bank Jago mobile application, utilizing the User Centered Design (UCD) methodology with a focus on usability. The research process included specifying the context of use, and requirements, creating design solutions, and evaluating the design. A questionnaire was distributed to 20 selected respondents to assess their perception of the prototype, which revealed a high level of acceptance, particularly for the insurance and Last Wish features. The study concluded that while the prototype met usability principles and could potentially assist users in financial planning, further design improvements and development are necessary. The research, published in the Jurnal Teknologi Informasi dan Komunikasi (JTIK), emphasizes the importance of user-centered approaches in UI/UX design to ensure user satisfaction and effective user experience.

1.10. User Interface (UI) Design on the Kopra Mandiri Application Dashboard (Other Bank Case Studies)

This open-access article presents the enhancement of the Bank Mandiri Dashboard application's User Interface (UI) using the ADDIE method, aimed at improving customer access to financial information and overall satisfaction. The UI redesign was implemented using web technologies such as HTML, CSS, JavaScript, React JS, and Antd for the Front end, and Java with Spring Boot for the Back end. A notable feature introduced is the "Other Bank/External Account Information," which allows customers to view their balance and transaction information from other banks within the dashboard. User trials were conducted to gather feedback, which indicated an increase in accessibility and convenience for customers managing their financial information. The paper suggests further improvements, including code optimization for the dashboard menu and regular updates to enhance security and maintain compatibility with evolving technology.

1.11. UI UX Analysis and Design Development of Less On Digital Startup Prototype by Lean UX

This research paper presents the development and evaluation of a digital startup prototype for a private tutoring service called Less-ON, focusing on UI/UX design using the Lean UX methodology. The study, set in Indonesia, highlights the significance of UI/UX for startup success and employs a research method that includes needs analysis, design, implementation, and testing with the System Usability Scale (SUS). The Less-ON mobile application prototype scored 85.53 on the SUS, indicating above-average usability and a positive user experience. The paper suggests the potential for further improvements through additional research and user testing, having gathered feedback from 52 respondents during

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the development process, which included stages such as observation, assumption declaration, MVP site map creation, and prototyping.

1.12. FDW Store E-Commerce Application Design using the Lean UX Method

This paper presents the development and testing of the FDW Store application prototype, an e-commerce platform designed to enhance the user interface (UI) and user experience (UX) for business owners. Utilizing the Lean UX method, which includes stages such as Declare Assumptions, Create an MVP (Minimum Viable Product), Run an Experiment, and Feedback and Research, the study aimed to create an intuitive and comfortable user interface. The FDW Store offers services like mobile credit for various operators, online game top-ups, and online bank payments. User testing yielded positive feedback, indicating that the prototype is a viable solution for business owners. The paper suggests that future research could employ the Guerrilla method to gather direct user data for further refinement of the design.

1.13. UX UI/UX Redesign of the Academic Information System Website at XYZ University Using the Lean UX Method

This paper discusses the redesign of the Ventela website using the Lean UX method to enhance user experience. A literature review was conducted to identify issues with the website's UI and UX, leading to assumptions and priorities for the redesign, which focused on creating an attractive interface, incorporating necessary features, and ensuring an intuitive website flow. The redesign included pages such as login, home, about, size chart, FAQ, contact us, and products. Data was collected through questionnaires, literature, and observation, revealing user issues such as a limited navigation bar, unappealing visuals, and the absence of a search feature. The Lean UX method was employed to design a Minimum Viable Product and test it with users, resulting in significant improvements in appearance, functionality, user experience, and increased product sales conversions. Feedback from 22 respondents post-redesign indicated a positive reception, with high ratings for design, usability, information readability, and accessibility, confirming that the website's redesign successfully addressed the identified issues.

1.14. Redesigning the UI/UX Design of the Pyramid Jaya Clinic Website Using the Lean UX Method

This paper details the application of the Lean UX methodology to redesign the UI/UX of the Klinik Piramida Jaya website, which had been closed due to the absence of a developer contract. The study followed Lean UX steps from data collection through questionnaires and interviews to creating problem statements, assumptions, hypotheses, and proto-personas, and testing a Minimum Viable Product (MVP) consisting of user flow and wireframes with potential users. The usability of the redesigned website was evaluated using the System Usability Scale (SUS), which indicated that the design was user-friendly and met user needs. The research aimed to facilitate user registration and information retrieval on the clinic's website, and the findings confirmed that the Lean UX approach was effective in creating a directed and user-centered design process, ultimately resulting in a prototype that improved the user experience for clinic appointment bookings.

1.15. Android UI/UX Design Tuition Payment Application Lean UX Method Case Study of the Al-Manshur Foundation

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This study focuses on the design of a web-based school fee payment application using the Lean UX methodology. The research resulted in a prototype that was tested by 21 users and received positive feedback. The findings underscore the importance of UI/UX design as a crucial step in application development. The paper concludes with a recommendation for future research to further develop the prototype design for both desktop and web versions and to enhance the prototype design in the future. The references included in the study cover topics related to information system design and user experience. Additionally, the journal discusses the UI/UX design for an Android-based school fee payment application, initiated by the Al-Manshur Foundation, which employed the Lean User Experience model. The initial phase involved creating wireframes for the prototype concept, which were then developed into a working prototype to serve as a reference.

2. METHODS

The following is the research methodology, which encompasses the stages carried out by the author in the study. The author opted for an implementative approach in its development. These stages include data collection, outcomes, assumptions and hypotheses, design, creating the Minimum Viable Product (MVP), research and learning, and concluding with conclusions and recommendations. The research method employed can be seen in the following diagram.

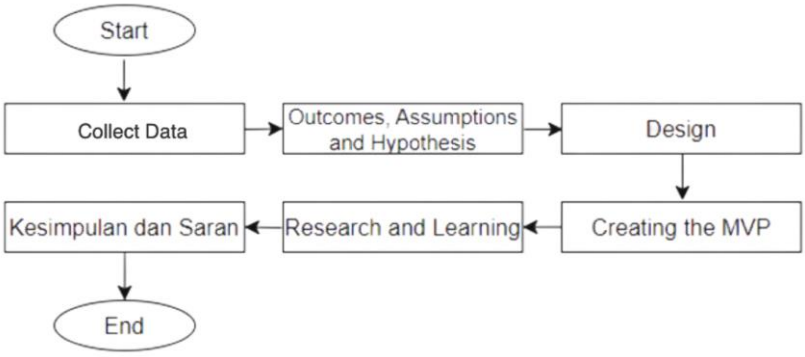


Figure 1. Diagram Research Methodology

2.1. Collect Data

In this stage, the author conducted data collection using the interview method. Through these interviews, the researcher aimed to gain a better understanding of the perspectives, experiences, needs, and personal views of users. The interviewees in this study were users who had previously used banking applications for an extended period.

Additionally, the researcher also conducted a literature review to identify relevant studies previously conducted. The sources of information used as references included scholarly journals, websites, and the results of the interviews conducted.

2.2. Outcomes, Assumptions and Hypothesis

In Lean UX, the outcomes, assumptions, and hypotheses process is one of the development steps of MTI Pay in the Lean UX method, which details the experiments to be conducted to test assumptions and achieve the desired outcomes. To create meaningful outcomes, the author designs the requirements needed by the user to be developed

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according to the target audience. The assumption declaration will contain an initial overview of the product to be developed. From these assumptions, the author can formulate hypotheses.

2.3. Design

In the design stage of Lean UX, the author engages in product design and hypothesis testing. The implementation at this stage involves creating sketches and wireframes to generate feedback.

2.4. Creating the MVP

In this stage, there is a follow-up to the design process, which involves the implementation of the creation of sketches and wireframes in the form of mockups. This process aims to obtain a visual representation of the user interface and user experience (UI/UX) of the MTI Pay system. In the design development, the author utilizes the Figma application. The author also creates prototypes in the design, making it easier for users to understand the user flow within the system, and obtaining feedback from users.

2.5. Research and Learning

This stage focuses on testing. The primary goal of the Lean UX process is to gain insights and feedback comprehensively. The author will pose several questions related to the system so that they can evaluate and measure the success of the system. evaluations to ensure that the developed system aligns with the expectations and needs of the users.

2.6. Lean UX

Lean UX is a design management system designed to assist in design through team collaboration, iterative processes, and frequent contact with users. In this system, there is a collaboration between the IT team and the Design team, aiming to shorten the handoff time of prototypes from the design team to the IT team.

3. RESULTS AND DISCUSSION

In this section, it contains the results of the research conducted, along with the discussion of the research design as outlined earlier. The results presented are the outcomes of the stages in the Lean UX method, including data collection, outcomes, assumptions and hypotheses, design, creating the Minimum Viable Product (MVP), research, and learning.

3.1. Collect Data

In this stage, the author collected information related to the design development of the MTI Pay system, and one of the methods used was interviews. The respondents in these interviews were users who had previously used banking applications for an extended period. In conducting data collection, the author established several criteria to obtain the best results. The following respondent criteria can be seen in Table 1 :

Table 1 Respondent Criteria

No	Questions
1	Aged 18-55 years old
2	Occupation as a student or employee anywhere
3	Residing in all regions of Indonesia
4	Proficient in Bahasa Indonesia as a native language

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5	Understanding of digital technology
6	Interest in the development of digital technology in banking
7	Have experience using banking applications

3.2. *Outcomes, Assumptions and Hypothesis*

This stage is derived from the previous stage, namely the data collection stage through interviews. From the interview results, there are several focuses that the author will use as considerations in the development of the MTI Pay system, including:

1. Transaction, including Fund transfers (local, international, others), Wallet for any purpose, Shariah-compliant interest, Multi-people wallet, and Insurance feature.
2. Islamic content: Sadaqah feature, Zakat feature, Islamic education content, Prayer reminder & Fajr Sadaqah reminder.
3. Gamification: Design focus for ease of use and attractiveness, Promo page for enjoyment, Animation when using the application, and Mini-games.

The users of the MTI Pay system to be developed are the general public with an average age ranging from 18 to 55 years. They are millennial and Gen Z users, generations proficient in using technology.

After the author successfully formulates assumptions about user needs, the next step is to determine hypotheses as a basis for creating visual designs. Table 2 below explains the hypotheses for the visual design of MTI Pay.

Table 2. Visual Design Needs

Component	Description
Color Palette	Color Palette used in the design to create a specific atmosphere and build brand identity
Typography	Selection and arrangement of fonts used to convey messages clearly and enhance visual appeal
Iconography	The use of icons or symbols to represent actions or information in an intuitively.
Layout	Arrangement of elements in the user interface, including contrast, white space, and component distribution.
Whitespace	White space between design elements to improve readability and enhance layout.
Responsive Design	Design that can adapt to various screen sizes and devices.

3.3. Design

This session focuses on the results of the design implementation, which is divided into two main parts: MVP Implementation and Feedback Response.

3.4. Creating the MVP

This stage begins with the creation of a low-fidelity model transformed from the previous stage. The low-fidelity model is created using the Figma application. Examples of the creation of a low-fidelity model for an educational game can be seen below.

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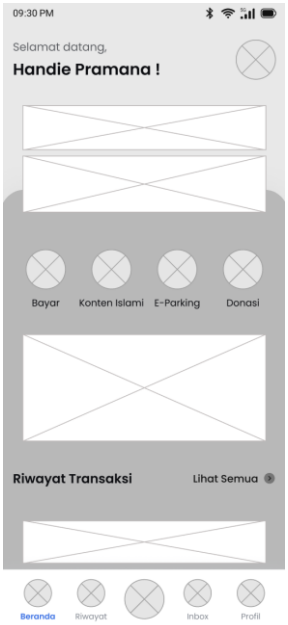


Figure 2. Low Fidelity



Figure 3. Login Page

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Figure 4. Verification Page

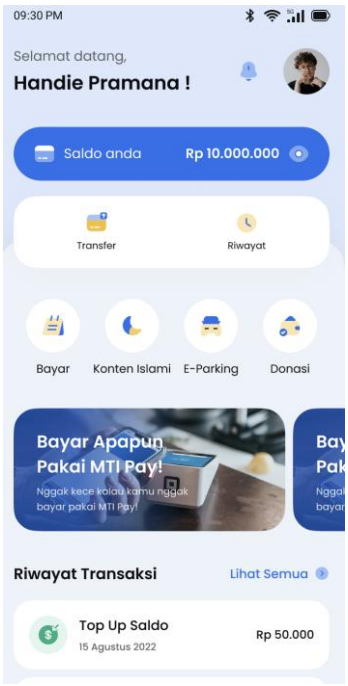


Figure 5. Home Page

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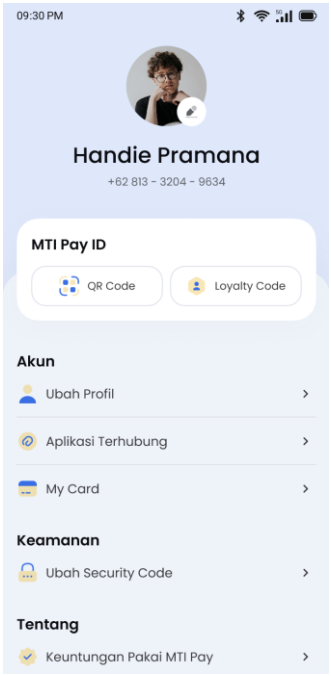


Figure 6. Profile Page

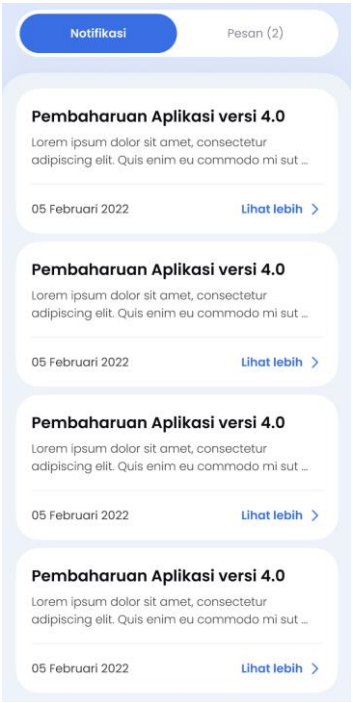


Figure 7. Notification Page

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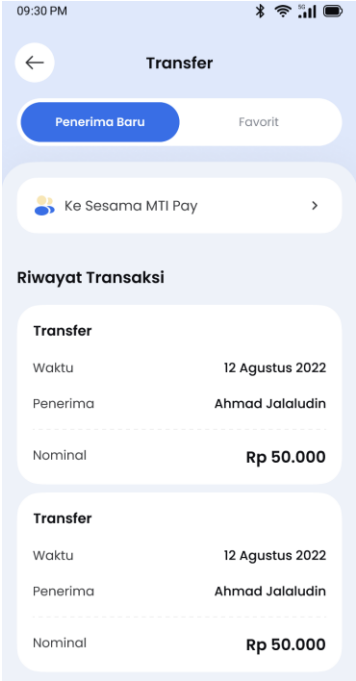


Figure 8. Transfer Page

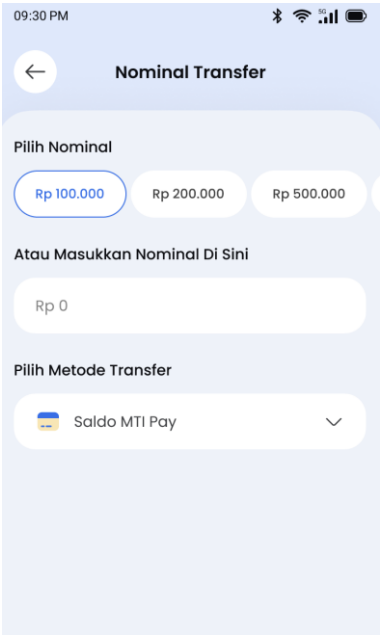


Figure 9. Transfer Detail Page

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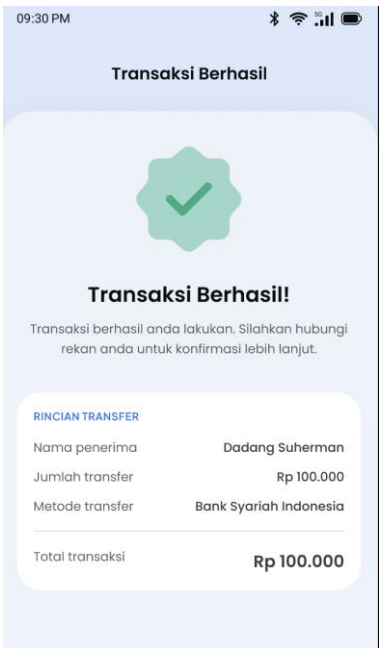


Figure 10. Transfer Success Page

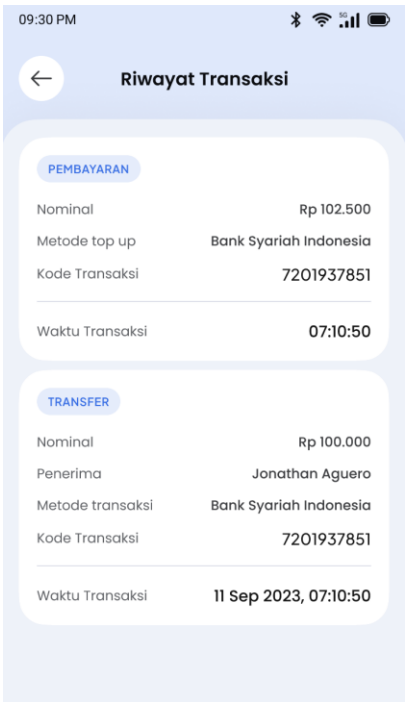


Figure 11. History Page

3.5. Research and Learning

In the next stage, there is feedback provided by respondents from a questionnaire similar to the previous stage, where this respondent feedback can serve as an evaluation for the development of the next research application. The following respondent feedback can be seen in Table 3.

Table 3. Feedback

No	Description
1	The design appearance is quite good and easy to understand for laypeople.

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2	The use of colors may need a little improvement to be more ingrained in the consumer's mind.
3	The presentation of information and the navigation sequence are easy to understand and learn.
4	The provided features are simple and meet the needs, so their utilization is very optimal.
5	In my opinion, it's okay, but some icons still are difficult to understand.
6	The prototype design is really good, from the design to the layout, it's neat and pleasing to the eye, and its features are easy to use.
7	Everything is already quite good, perhaps the use of font sizes could be improved to make it more visible.
8	Maybe some features like frequently searched recommendations could be added to make it more user-friendly.
9	love the features, perhaps the use of brighter colors could make the vibes look more cheerful.
10	Efficient and effective for its features, maybe the use of colors could be in pastel colors(?).

4. CONCLUSION

In conclusion, MTI Pay emerges as a solution to address the challenges faced by the banking sector in the competitive landscape of technology and globalization. The rapid evolution of technology and the emergence of numerous startup companies have intensified competition in the banking industry. To thrive in this environment, businesses, including MTI Pay, must adapt by providing innovative and user-centric solutions.

MTI Pay's introduction of a super bank, leveraging advanced technology for a more personalized and easily accessible banking experience, reflects a strategic response to the changing landscape. The incorporation of the Lean UX method in the design process demonstrates a commitment to user satisfaction and continuous improvement. This method, with its focus on reducing unnecessary processes and iterating based on user feedback, is poised to enhance the user experience in the MTI Pay system.

The implementation of Lean UX is well-aligned with the need for efficiency and effectiveness in product development, especially in a rapidly evolving technological landscape. By prioritizing user-centered design and iteratively refining the application, MTI Pay aims to stay competitive and meet the evolving needs of its users.

In summary, MTI Pay's strategic approach to technology, user experience, and design methodologies positions it to not only survive but thrive in the dynamic banking industry. The emphasis on innovation, adaptability, and user satisfaction sets the foundation for MTI Pay's success in providing a superior banking experience in the era of globalization and rapid technological advancement.

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Prototype of IoT-based Clothes Drying Control System using Infrared Thermometer MLX90614

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ABSTRACT

The recent climate change has caused instability in seasonal transitions, consequently complicating weather predictions especially in rainy seasons. This situation presents several challenges, particularly in the context of outdoor clothes drying, especially when the house is left empty or there is no one inside. Moreover, public clothes washers use the same place for different types of clothes and use chemicals that often damage clothes. This can be prevented by washing at home. Hence, there is a need for automated clothes drying device when rain detected. Our prototype utilizes a raindrop sensor, infrared thermometer MLX90614, and implements the Internet of Things (IoT) that employs a telegram bot for monitoring and control, thus enabling the avoidance of weather instability effects on clothes drying, ensuring clothes are dried automatically when it's not raining. Functional software testing results indicate the device operates effectively, though in hardware there are still issues with the stability of motor movement, which will be addressed in further research stemming from this article.

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1. INTRODUCTION

A clothesline is a simple device used for drying clothes outdoors. It typically consists of a rope or wire stretched between two points, such as poles or hooks, where wet laundry can be hung to air dry. Clotheslines are commonly used in residential settings, especially in areas where dryers are not readily available or to save energy costs by avoiding the use of electric or gas-powered dryers. They come in various forms, including traditional T-pole clotheslines, retractable clotheslines, and umbrella-style clotheslines [1]. Clotheslines offer an environmentally friendly and cost-effective method for drying clothes, utilizing natural sunlight and airflow to dry garments. The recent climate change has caused instability in seasonal transitions, consequently complicating weather predictions. This situation presents several challenges, particularly in the context of outdoor clothes drying [2]. Although air drying of clothes outdoors is considered an economical option as it does not require special equipment, this method has its drawbacks, especially when rain suddenly arrives without any supervision to move the clothes affected by the rain.

In order to address these challenges, the implementation of the Internet of Things (IoT) in clothes drying management has emerged as an innovative solution. IoT refers to a network of interconnected physical devices that can communicate over the internet [3][4]. In this context, the implementation of IoT in clothes drying aims to provide better supervision and control over the drying process. In an IoT system for clothes drying management, integrated sensors on the clothesline and garments function to detect weather and environmental conditions. Information obtained from these sensors is transmitted to a platform or application accessible to users via mobile devices or computers. With this capability, users can monitor the status of clothes drying in real-time and receive immediate notifications if there are weather changes that could affect the drying quality. One of the main components in this IoT system is the smart clothesline. Equipped with an automatic mechanism, this clothesline can move clothes indoors if the weather worsens or rain suddenly arrives. Weather sensors installed on the clothesline can detect humidity and rainfall, enabling the clothesline to make decisions based on environmental conditions [5]. The clothes being dried can also be equipped with humidity sensors that send data to the IoT platform. This helps prevent excessive humidity that can damage clothes, such as mold growth or unpleasant odors. This IoT system can be integrated with other smart devices in the home, such as virtual assistants or automated settings. For example, users can schedule clothes drying times according to their schedule or preferences, enhancing efficiency and convenience in clothesline management [6][7]. The advantages of using an IoT system in clothesline management include time and energy efficiency, as well as in various other fields [8][9][10]. Users no longer need to repeatedly lift and lower clothes when the weather changes or to avoid rain. Furthermore, better supervision of the drying process helps maintain clothing quality more effectively, avoiding potential damage due to prolonged exposure to sunlight or excessive humidity. In the face of uncertain weather conditions, the use of IoT technology is crucial in providing convenience and efficiency in clothesline management. This system is designed to provide comfort for users, whether they are outside the home or in other situations. Thus, all clothes on the clothesline can be protected from rainwater, and users no longer need to repeatedly perform the task of lifting and lowering the clothesline.

2. METHODS

For this research, we adopt the waterfall method, the waterfall method is a traditional software development model that follows a linear and sequential approach. In this method,

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each phase of the software development life cycle (SDLC) is completed sequentially, with the output of one phase serving as the input for the next phase [11][12]. The phases typically include requirements gathering, system design, implementation (coding), testing, deployment, and maintenance. The waterfall method is a sequential development approach, following structured stages like a waterfall. This model involves requirements analysis, design, coding, testing, implementation, and program maintenance [13][14][15]. Although considered to have significant risks and higher costs due to meticulous replanning, this method tends to produce accurate and detailed research, as shown in **Figure 1**.

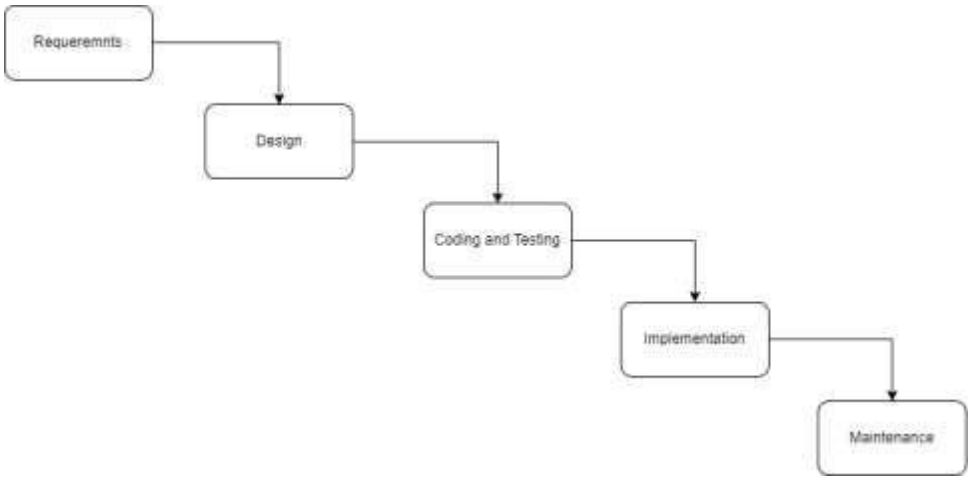


Figure 1. Block diagram of waterfall method

In **Figure 1**, there are five stages in creating the system, starting from requirements analysis to implementation and maintenance. The requirements analysis stage involves selecting IoT hardware, development software, and weather data to be processed. In the design stage, requirements are translated into blueprint designs to facilitate the coding and testing process. The coding and testing stage involve implementing the design into a tangible system. Functional testing is conducted using black box testing techniques to ensure the system can read and interpret weather data. The fifth stage involves implementing the system to protect the clothesline from rain automatically. Finally, the maintenance stage is necessary for system upkeep and development over time [16]. Although the waterfall method is rarely followed strictly due to evolving software specifications and versions, as well as a lack of user feature requirement information, it remains the foundation for structured system development.

2.1. Hardware Configuration

The hardware configuration for the prototype of IoT-based clothes drying control system includes a microcontroller or development board such as Arduino or Raspberry Pi, the Arduino UNO is a microcontroller board utilizing the ATmega328P. Featuring a 16MHz ceramic resonator, a power jack, USB connectivity, a reset button, and an ICSP header, it offers 14 digital input/output pins (with 6 configurable as PWM outputs) and 6 analog inputs [17][18]. This versatile board is capable of self-sustained operation, allowing power from either a battery or an AC-to-DC adapter. In addition, various sensors like raindrop sensors for detecting rainfall and temperature sensors for measuring ambient and object temperature, actuators such as DC motors for moving the clothesline and fans for drying clothes, communication modules like Wi-Fi or Bluetooth modules for connectivity, a power supply which could be batteries or a dedicated power source, and additional components like breadboards, resistors, and capacitors for circuit connections as shown in **Figure 2**.

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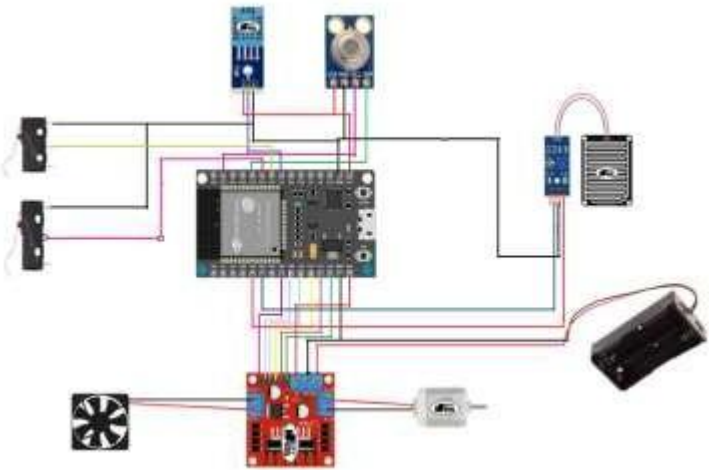


Figure 2. Wiring diagram of proposed device

Based on the wiring diagram in Fig.2, the device comprises several components: a Raindrop Sensor for detecting rainwater, an ESP32 for controlling the system, an L298N Driver to activate and regulate the DC motor, a DC Motor for moving the clothesline rope, a Fan for clothes drying, a Battery Socket for power supply, an MLX90614 Sensor for detecting object temperature (clothesline), a DHT11 Sensor for humidity detection, and a Micro Switch for manual clothesline rope movement triggering. After the wiring diagram is explained, we refer to a broader overview, namely the system architecture as shown in **Figure 3**.

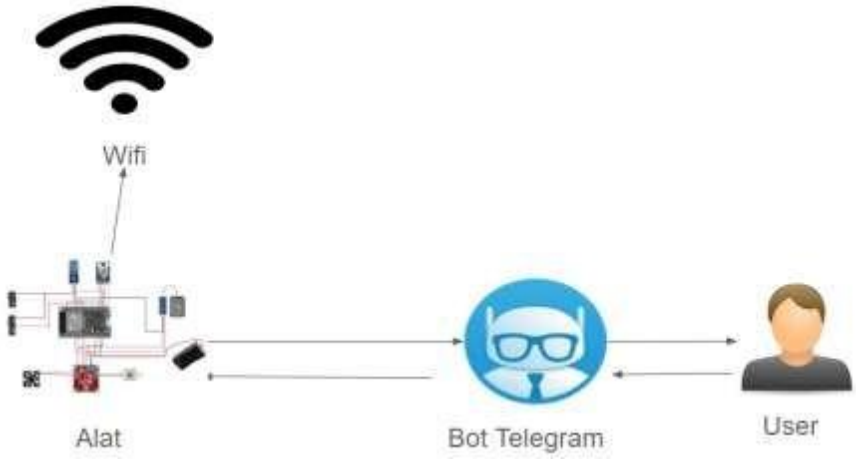


Figure 3. Proposed architecture.

In Fig. 3, we use telegram bot, additionally, an internet-connected device, such as a smartphone or computer, is required for receiving and ending messages to the IoT platform, typically using services like Telegram for control and monitoring purposes as done also by [19][20].

3. RESULTS AND DISCUSSION

We created miniature automatic clothes drying device using wood materials assembled in a specific manner and combined with the hardware components mentioned above. For the clothesline, we used strong thread to attach miniature paper clothes, which served as the objects to be dried. In this manufacturing stage, we primarily focused on developing the prototype first, which we will further refine. Consequently, we acknowledge certain

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weaknesses, yet testing on this system has demonstrated its success with minimal requirements. Test results include hardware and software testing at a functional scale only; reliability testing will be conducted on a full-scale device. The results of our prototype device are illustrated in **Figure 4**. Prototype Device.



Figure 4. Prototype device

3.1. Functionality Testing

Hardware testing is conducted to assess the functionality and performance of each component used. The testing involves evaluating the system's performance, determining whether the sensors can effectively detect rainfall, and testing the overall functionality of the device to ensure it operates properly as we can see in **Table 1** for the result of hardware testing.

Table 1. Hardware testing.

Sensor	Expected Result	Test Result	Explanation
Raindrop	The Raindrop Sensor is tested by simulating rainfall, typically by wetting the sensor with water. When the sensor detects water, it triggers the DC motor to rotate, indicating that it can effectively detect rainy conditions.	The sensor can detect water on its surface, and the DC motor rotates accordingly.	Detected
DHT11	The sensor can detect ambient humidity.	The sensor successfully obtains ambient humidity data	Detected
MLX90614	The sensor can detect the temperature of objects within a radius of 10-15cm. If the temperature of the object (clothesline) is below 28°C, the fan will turn on, and if it is above 28°C, the fan will not turn on.	The sensor can recognize the temperature of the object (clothesline) as well as temperature variations. If the object's temperature is below 28°C, the fan turns on, and if it is above 28°C, the fan turns off.	Detected

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3.2. Software Testing

Software testing is a process that determines whether the functions of the commands created in the Telegram bot work effectively in monitoring and controlling the clothesline device as shown in **Figure 5**.

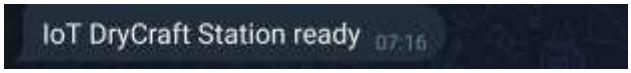


Figure 5. Bot telegram that states IoT device ready

The image above shows the display of messages from the Telegram bot when the device is connected to the internet and ready to operate. After that, we tested the scenario if rainwater is detected and the Telegram bot displays as shown in **Figure 6**.

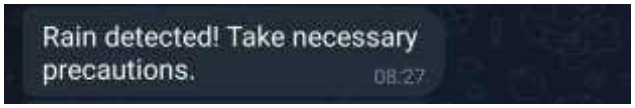


Figure 6. Bot telegram that detects rain condition

In **Figure 6**, after the condition indicates rainfall, we proceeded to test the temperature and humidity sensors as well as the DC motor to verify if they work and provide notifications on the Telegram bot, with the test results shown in **Figure 7**.



Figure 7. Commands in bot telegram for controlling and monitoring device

The image above depicts monitoring and controlling commands, along with system responses for the designed device, featuring functions such as /temp for ambient temperature monitoring, /humidity for humidity monitoring, /tempobject for object temperature monitoring (clothesline), and /tarik for controlling the DC motor to pull the clothesline indoors.

4. CONCLUSION

Based on the conducted research, it was found that the design of the prototype of iot-based clothes drying control system automated clothesline device functions well. This automation device can detect rainy conditions and automatically move the clothesline indoors when rain is detected. Additionally, the device can activate the drying fan

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automatically when the object detected within the sensor's range is below 28°C. Finally, the implemented monitoring and controlling functions in the Telegram bot also work well. The designed bot will automatically send messages when the device is in certain conditions, and the monitoring function works effectively, with the bot delivering requested information accurately and promptly. Meanwhile, the waterfall method has its advantages in terms of clarity and structure, it also has drawbacks, such as limited flexibility to accommodate changing requirements and the potential for late-stage errors to be costly to rectify, therefore, for future research, we aim to address this issue and the stability of the motor in rotating the clothesline rope outward and inward.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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Implementation Simulation Application of Library Accreditation Assessment of Indramayu State Polytechnic

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ABSTRACT

A library is a place that contains a collection of library materials used for study purposes or for reading purposes only. However, there are some libraries that have not implemented an assessment system in their management. Therefore, it is necessary to have a system as a supporting material to meet the accreditation assessment standards that have been set. So, an application was made to assist in conducting an assessment at the Indramayu State Polytechnic Library using the Laravel framework and in its development using the waterfall method. With this application, it is hoped that it will be able to facilitate the library in conducting assessments to achieve assessments that are in accordance with predetermined standards. The focus of this application development is focused on the accreditation assessment simulation process in the library. The results of the tests that have been carried out are running well, this application has succeeded in meeting the expectations that have been set previously, namely with an average value of 83.3% of the questionnaire calculation results.

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1. INTRODUCTION

According to the Random House Dictionary of the English Language, a library is a place, in the form of a room or building that contains books and other materials for reading, study or reference. Libraries are not only for storing and searching books but also for finding a variety of information, from scientific information, and history to popular information [1]. However, for Higher Education libraries only provide information related to needs such as scientific or semi-scientific and some fiction stories. When compared to public libraries, they usually provide more information that is semi-scientific to popular information but, some public libraries provide information related to history, fiction stories to actual and factual information.

In the Indramayu State Polytechnic library, many library materials related to various information such as scientific information, history, and fiction stories are found in this library. however, at this time the library world continues to be faced with demands for the quality of services provided. In the end, the library must always be responsive and adaptive to every change and progress that is useful for improving service quality.

Nowadays, libraries are always related to assessment or evaluation. Assessment is a form of appreciation of an organization or institution that is used to determine eligibility or synchronous standards using certain qualifications that can reflect the quality of an organization. The benefit of this assessment is to evaluate the performance of the library. Therefore, it is necessary to have a system as a simulation support in the assessment carried out to improve the quality of library performance.

2. METHODS

This Accreditation Assessment Simulation Program works directly with application users who will be applied at Indramayu State Polytechnic which aims to help facilitate accreditation assessment in the library. The location of this library is within the scope of the Indramayu State Polytechnic, namely, in the GSC Building 2nd Floor.

From the problems found in the library, it is hoped that this application [2] can facilitate the accreditation process precisely and quickly. The implementation method of the library accreditation assessment simulation program that will be carried out is as shown in **Figure 1**:

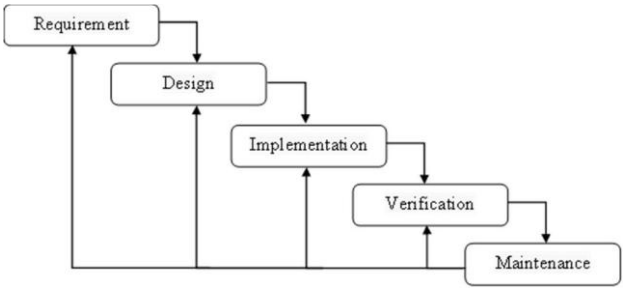


Figure 1. Activity Flow.

From **Figure 1**, the stages of the library accreditation assessment simulation program activities are divided into 5, namely requirements, design, implementation, verification, and maintenance [3-5].

The requirement stage is the stage for identifying problems found in partners, namely the interview process with the Indramayu State Polytechnic library team which aims to

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determine the creation of a system that will be made according to partner needs. The second stage is design, after analyzing the needs of the library and getting the results of the analysis, the results can be used to determine functional requirements, design databases and create mockups. The third stage is implementation, at this stage you can implement the system design that was previously made. Implementation of the library system consists of user pages or visitor pages, and admin pages. The fourth stage is verification, at this stage, a test will be carried out by the library team to find out if the system that has been made meets the functional needs. The last stage is maintenance, at this stage a periodic inspection of the system that has been made is carried out to know the function of the system is still running well or not.

3. RESULTS AND DISCUSSION

This research produces a library accreditation assessment simulation application designed using the Unified Modelling Language (UML) [6-8] which consists of use cases [9], [10] activity diagrams [11], [12], flowcharts [13], [14], and class diagrams [15], [16]. This system is made using Visual Studio Code software for writing application program code and using the PHP programming language [2], [17] with the Laravel framework [18], [19]. The results of the design and manufacture that have been carried out in this study produce an Indramayu State Polytechnic Library Assessment Simulation Application. This system is used to conduct accreditation assessments and provide information on the library.

3.1 Database Implementation

In making this accreditation assessment application, a database is needed, the purpose of the database is to store every data in the accreditation application [20], [21] The tables contained in the accreditation assessment application are user tables, accreditation tables, news tables, library team tables, image slider tables, category tables, service tables, component tables, sub-component tables, sub-sub component tables, question tables, sub-question tables, and option tables.

3.2 System Design

System design is a design or description of the system to be created. With the system design, it can be modeled using functional modeling and can make the application because there is already a flow picture of the system to be created [22]. The data process of the accreditation assessment simulation system can be modeled with use case diagrams, activity diagrams, and class diagrams.

1) *Use case diagram*

In general, use case diagrams can be used to represent the purpose of system interaction with users. Use case diagrams on the Library Assessment Simulation Application have two actors, namely admin and visitor actors as shown in **Figure 2**.

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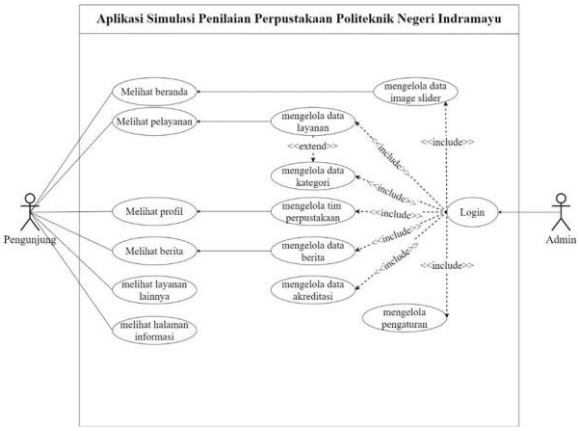


Figure 2. Use Case Diagram.

3.3 System Implementation

This stage is the system design stage that implements the program environment, such as implementing the user interface.

1) Landing Page

The implementation of the landing page interface is displayed when library visitors want to find information related to library materials or just want to see the facilities in the library as shown in **Figure 3**. On the landing page there is a profile menu in which there is a profile related to the library, on the service menu contains services or facilities in the library, on the other services menu contains e-books that have been provided by the library, and finally the information menu contains contact information and library operating hours. In addition, there is a display of news or announcements in the library.

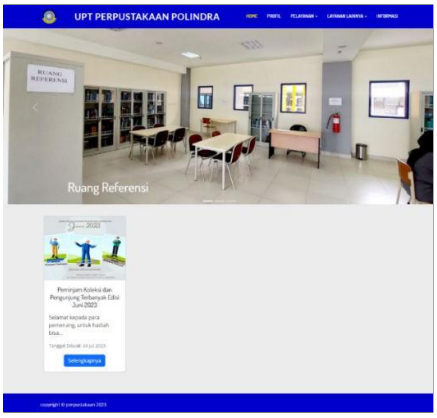


Figure 3. Landing Page.

2) Login Page

The login page is displayed when the admin or library team wants to update data such as slide images on the home page, news on the home page, an organizational structure that appears on the profile page, updates related to photos or service descriptions in the service menu, and wants to update the assessment in accreditation. **Figure 4** shows the interface of the login page.

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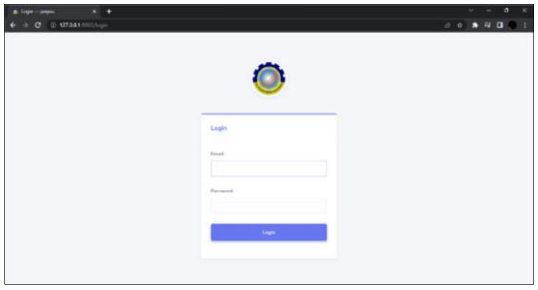


Figure 4. Login Page.

3) Accreditation Page

This page is displayed when the admin wants to update library-related assessment data or can be called an accreditation assessment. The accreditation process is carried out when the admin chooses the components that he wants to assess according to his needs. 9 components need to be assessed in this accreditation system, after the component has been answered, a value will appear which will determine accreditation. If the value does not meet accreditation, it will appear that the library does not meet the accreditation assessment. However, the score can be done repeatedly according to the updates in the library. When the assessment has been done, the results can be saved as needed. **Figure 5** shows the interface of accreditation page.

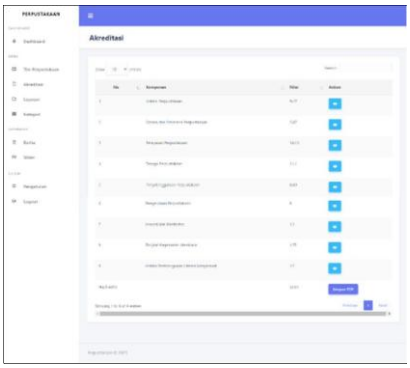


Figure 5. Accreditation Page.

3.4 System testing

This stage is a stage carried out after the system implementation has been completed, the system needs to be thoroughly tested to ensure whether the system is in accordance with the software requirements or not. This test usually includes functional testing and feature testing contained in the system.

1) Questionnaire testing

Application testing through this questionnaire was carried out by involving 5 levels of respondent users as shown in **Table 1** [23-26]. Each respondent will be asked questions about the feasibility of the Indramayu State Polytechnic Library Assessment Simulation Application.

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Table 1. Value Index.

Value Index	Description
A	Very good
B	Good
C	Simply
D	Less
E	Very Less

Based on the results of testing through a questionnaire on the Indramayu State Polytechnic Library Assessment Simulation Application, it runs well. The results of the percentage of testing using a questionnaire for 2 levels consisted of 10 respondents for the admin, and 11 respondents for visitors. With a total of 21 respondents, the average value of the questionnaire calculation results was 83.3%. From these results, it shows that the application that has been made is in a good category to use.

4. CONCLUSION

The conclusions that can be drawn after collecting, processing, analyzing, implementing, and testing the Indramayu State Polytechnic Library Assessment Simulation Application are as follows:

1) This application is made only web-based using the waterfall development method and the Laravel framework.
2) This application was created to assist the library in accreditation assessment and as supporting material for accreditation, which will later bring up the value obtained when the library team fills in the answer choices in this application.
3) This application can help library visitors to get information related to the library and can find out about the facilities in it.
4) The results of the tests that have been carried out in chapter 4 are running well, this application successfully fulfills the previously expected categories and is good for use.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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Library Management System Design in SMA 6 Madiun

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ABSTRACT

Currently, all library lending, returning and data collection activities at SMA Negeri 6 Madiun are done manually. This is highly inefficient as it wastes paper, generates erroneous data, and results in disorganized and untidy filing. The purpose of this study was to design, build, and implement a website-based library management system at SMA 6. In this study, the system development method used is waterfall. Through the stages of requirements, design, coding and testing, integration and testing, and operations & maintenance. The result of this research is the library management system. The conclusion in this study is that a library management system will be able to improve and make work simpler, faster, and more accurate. can facilitate the management and borrowing of books for librarians and library visitors.

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Library,
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Waterfall Method.

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1. INTRODUCTION

The use of information technology in the world is developing rapidly and has many positive impacts on society. Technology is increasingly being used in many sectors to simplify repetitive and difficult jobs. Libraries will continue to change as technology advances, which allows them to provide convenience, information accessibility, and collaboration with other libraries to share information and achieve common goals [1].

The purpose of the school library is to assist students in obtaining the information they need [2]. To support the learning process in schools or educational institutions, libraries are facilities and infrastructure that must be owned by both schools and educational institutions. They serve as a valuable source of teaching and information. This is a very quiet location which is often used for reading books or looking up references. This location is very useful for students because they can use it to borrow books for free to complete homework. Books are often borrowed, returned, and documented in a handwritten ledger of every action.

In the city of Madiun, East Java, there is a high school called SMA Negeri 6 Madiun. On Jl. Suhud Nosingo, Kel. Mojorejo, Kec. Taman, Madiun City, is where this high school is located. Currently, all library lending, returning, and data collection activities at SMA Negeri 6 Madiun are done manually. This is highly inefficient as it wastes paper, generates erroneous data, and results in disorganized and untidy filing. Employees must verify and physically search for books that have been borrowed. It took a lot of time and effort to do this, and as a result, many books were lost because it was not clear who had borrowed them. As a result, having a system that incorporates library knowledge is critical, especially considering how fast technology is developing.

Researchers will create a website-based library management system based on the problems mentioned above. It is envisioned that the availability of library management systems will improve and make work simpler, faster, and more accurate. can facilitate the management and borrowing of books for librarians and library visitors.

A system is a collection of components that work together in a network regularly to achieve a specific purpose or goal [3]. Information can be interpreted as the result of various data processing that has been arranged in such a way as to suit the needs of the user. Data, on the other hand, refers to a collection of numbers or characters that have a specific meaning and are taken from the reality or situation that exists in a location [4]. Information is also data that has been processed in a way that increases user knowledge [5]. An information system is a group of people and capital resources in an organization that is responsible for collecting and managing data to produce useful information for every level of management in planning and controlling organizational activities [6]. Information systems can be in the form of an organized combination of people, hardware, software, networks, communications, and data resources that are used to collect, modify, and disseminate information within an organization [7]. An information system is a collection of subsystems that store certain data that can be presented and used to make choices [8].

Information and communication technology (ICT) is a resolution to the use of computers, the internet, and other telecommunication technologies in every aspect of human endeavor. Information and communication technology (ICT) is the handling and processing of information (in the form of text, images, graphics, instructions, etc.) for use, through

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electronic means and communication devices such as computers, cameras, and telephones [9]. To support the learning process in schools or educational institutions, libraries are facilities and infrastructure that must be owned by both schools and educational institutions. They serve as a valuable source of teaching and information [8]. A website is a collection of connected web pages that can be viewed via an internet connection for individual, business, and organizational needs and includes information in the form of text, photos, animations, audio, and video [10].

HTML is a web programming language that instructs web browsers on how to organize and display content on web pages. HTML is abbreviated as "Hyper Text Markup Language", and its full name is "Hyper Text Markup Language" [11]. PHP is an open-source program used in designing and implementing websites. PHP is a powerful scripting language and is used in a variety of software technologies such as content management applications, online businesses, dynamic website development tools, and chat software custom applications [12]. In the world of web development, PHP is widely used. One of the reasons why PHP is so popular is because it is very easy to learn compared to other scripting languages [13].

The database is a compiled collection of records that can be searched and retrieved digitally from a computer [14]. MySQL is a popular RDBMS that is fast and easy to use for a variety of purposes. MySQL AB Sweden is the company that made it [15]. Frameworks are software with a framework architecture that programmers can use to create desktop, mobile, or web-based applications. It is thought that the basic framework instructions and functions, which can be used to create application software, will enable applications to be created more quickly and with a highly organized structure [16]. Laravel is a framework that can help programmers take advantage of PHP during website creation. Apart from that, Laravel provides several excellent features, including routing, modularity, and a template engine[17]. The relational database conceptual model is represented graphically by an entity relationship diagram (ERD). Entity Relationship Diagram (ERD), often known as the relationship between entities, is a graph that shows how things in the real world are related to one another. Relational database modeling is carried out using ERD [18].

This research is motivated by research gaps in previous studies. Based on the results of research with the title "Web-Based Library Information System Design at SMP N 22 Muaro Jambi" [19]. Based on the results of a research titled "Design of Library Information Systems at MTS Negeri 3 Jambi City" [3]. Based on the results of research with the title "Web-Based Library Information System Design at Stikubank University Semarang" [5]. Based on the results of research with the title "Design of Website-Based Library Information Systems" [20]. shows that in the seven studies, there was no use of a framework in making the website.

The purpose of this study was to design, build, and implement a website-based library management system at SMA 6. The difference between this research and other studies is that this library management system was built using the Laravel framework which has a better security system. One of Laravel's security systems is PDO which can prevent SQL Injection.

2. METHODS

The place of this research is on the Madiun 6 State High School Campus which is located on Jl. Suhud Nosingo, Kel. Mojorejo, Kec. Park, City of Madiun. In this study, the waterfall application development methodology is applied. Through the stages of Requirement,

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Design, Coding and Testing, Integration and Testing, and Operation & Maintenance, progress is seen as a continuous flow down (like a waterfall) in a sequential software development waterfall approach [21]. **Figure 1.** is a chart of the waterfall method which can be seen in the image below:

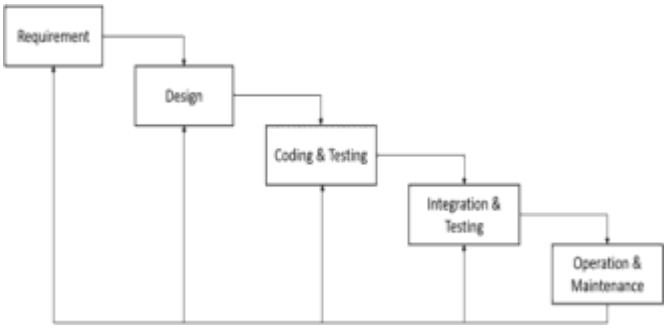


Figure 1. Waterfall method [21]

The stages contained in the waterfall method that the researcher uses are as follows: Requirements (Needs Analysis) On this occasion, the researcher spoke with the librarian at SMA 6 Madiun and saw them in action. These interviews focused on the issues raised by employee complaints, which were then used to determine what requirements should be included in the system design. Design (System Design) Researchers model the system according to the requirements at the design stage of the system to be built. Flowcharts, DFD, ERD, database architecture, and system interfaces are all produced by researchers. Coding & Testing Program code will be generated using Notepad++ during the coding phase. PHP and HTML are the programming languages used. The database application uses XAMPP, and testing is carried out using a black-box testing approach to detect potential system weaknesses and fix them immediately. Integration & Testing (Program Implementation and Testing) At this stage, users or employees will receive a ready-made program to use and run in the SMA 6 Madiun library. Operation & Maintenance (Maintenance) The system that has been operating in the SMA 6 Madiun library is now under maintenance. When maintenance is carried out, bugs are fixed and desired additions or functionality are added [21].

The data collection technique in this study was observation to collect the information needed for system development, such as book data recap, book borrowing, and book return. The researcher made face-to-face observations at the SMA 6 Madiun library. An Interview with The library management team became a research resource to obtain information about issues that were developing at SMA 6 Madiun. The interviews covered the following subjects: book data processing, book borrowing, and book return. Literature Study By reading and reviewing reference materials, the writer uses this strategy to collect data from sources that are relevant to research writing.

4. RESULTS AND DISCUSSION

The result of this research is a website-based library management system at SMA 6. Relevant research studies in this research are based on research with the title Web-Based Library Information System Design at SMP N 22 Muaro Jambi showing that this application can improve librarian performance in managing data faster because the system has data management features for returns and loans [19]. Based on the findings of the study entitled Design of Library Information System MTS Negeri 3 Jambi City, information systems can process data more quickly and easily and do not require a long time to process data, both in

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the data search process and in calculating fines [3]. With this method, can provide loan reports more quickly and accurately.

Based on research findings with the title Web-Based Design of Stikubank Semarang University Library Information Systems, library information systems can further accelerate the ability of library administrators to search and facilitate every transaction in the library [5]. and filing is neatly organized because everything is computerized. According to the findings of the study titled Design and Build a Website-Based Library Information System, a web-based library information system can overcome the problems currently experienced by the library at SMP Negeri 1 Pace [20].

The interpretation of the findings in this study is that this library management system is equipped with a login menu, user menu, member menu, book menu, loan menu, loan detail menu, return menu, return detail menu, and reports. The limitations of the research in this study were that this research was only conducted at SMA 6 Madiun. The implication of implementing this library management system is that it can improve and make work simpler, faster, and more accurate. can facilitate the management and borrowing of books for librarians and library visitors. In addition, it makes it easier for users to access the system online.

3.1 System Planning

System planning starts by constructing a Data Flow Diagram (DFD), Entity Relationship Diagram (ERD), and database structure. **Figure 2** is a flowchart for the system admin and **Figure 3** shows Data Flow Diagram (DFD) Level 0 of the system built.

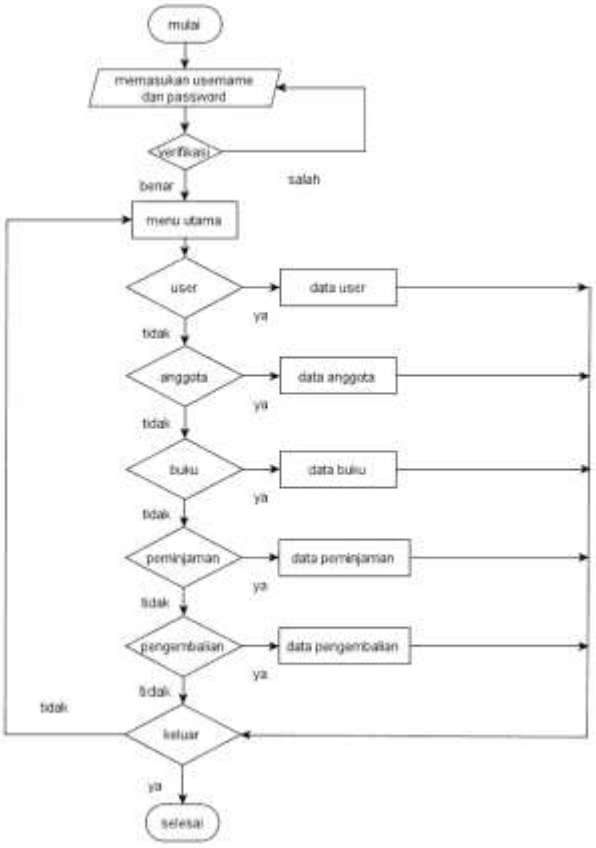


Figure 2. Flowchart Admin

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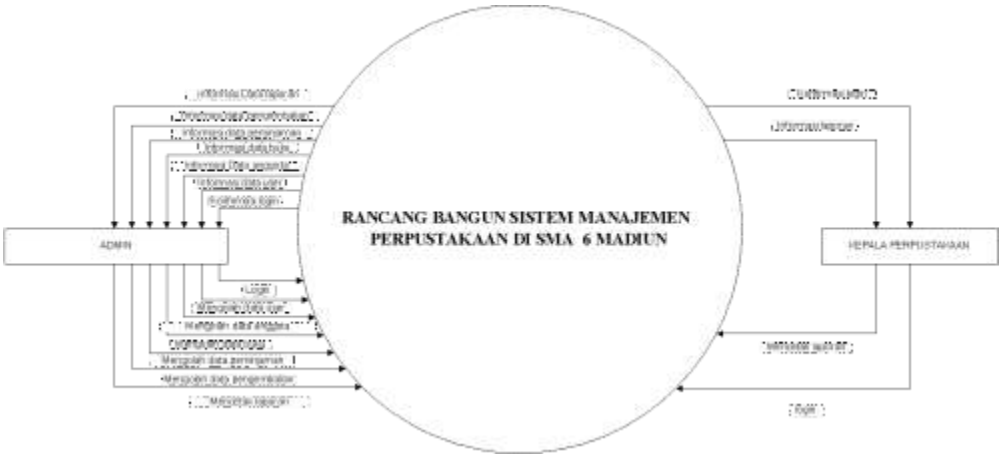


Figure 3. DFD Level 0

Then, **Figure 4**. shows DFD level 1 of the system being built.

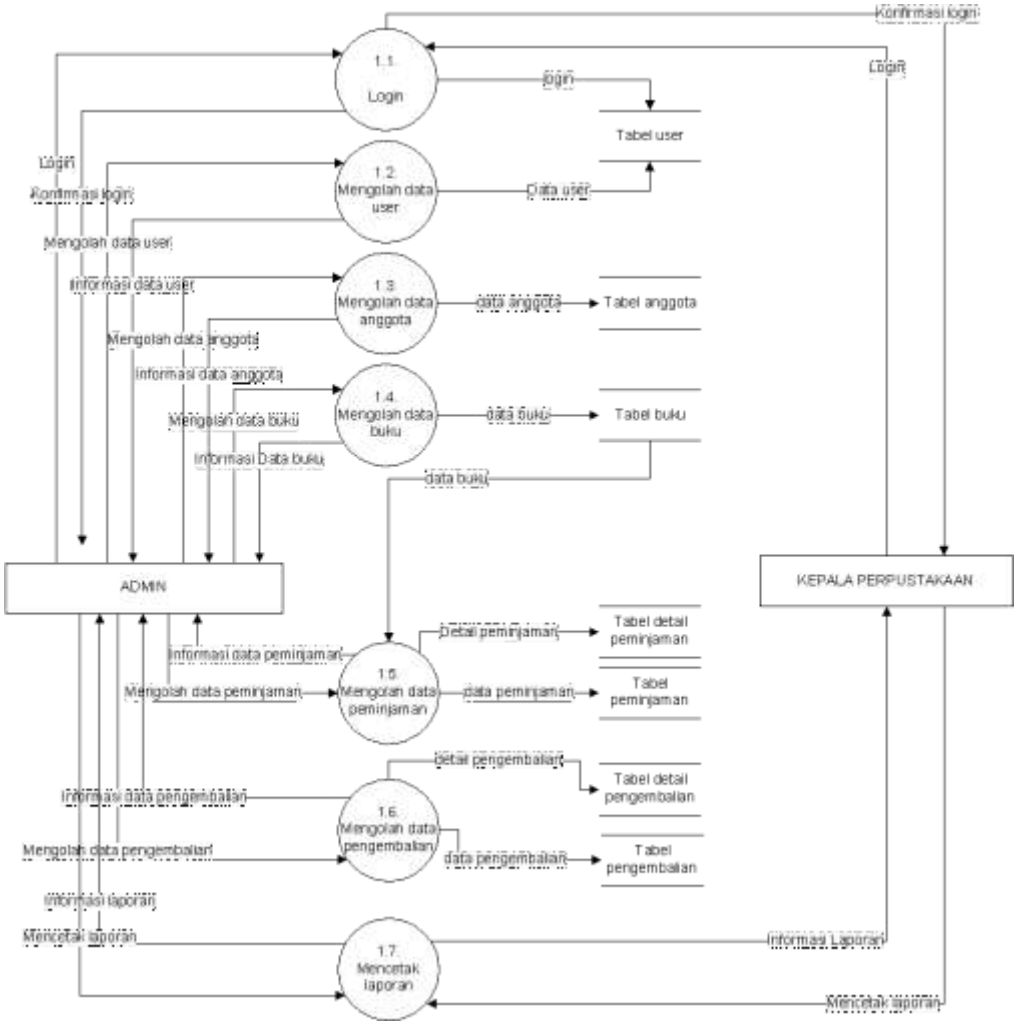


Figure 4. DFD Levels 1

In **Figure 5**., we can see the Entity Relationship Diagram (ERD) of the system being built.

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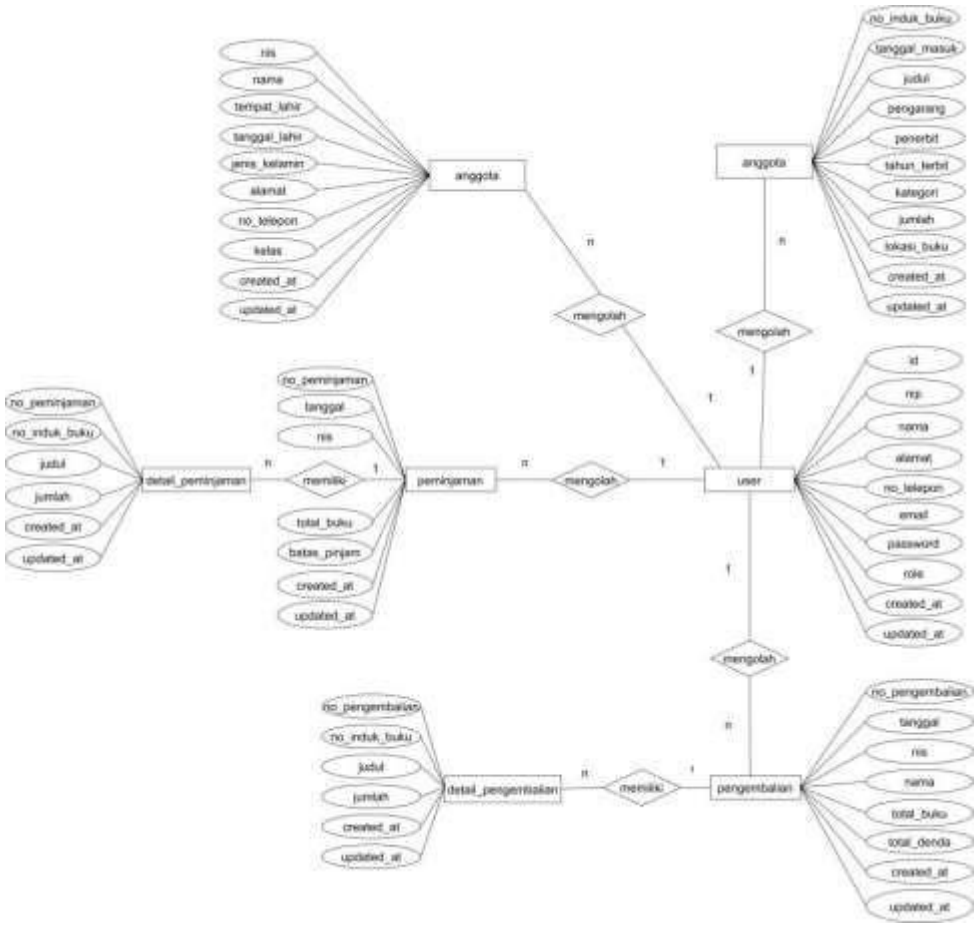


Figure 5. Entity Relationship Diagram of system

For the database structure, there are some tables used. The member table structure is shown in **Table 1**. This table is used to store member data. To store the book data, the database structure follows **Table 2.**

Table 1. Member Table

No	Name	Type	Size	Key type
1	**is**	*int*	20	*Primary Key*
2	nama	*varchar*	75	
3	tempat_lahir	*varchar*	25	
4	tanggal_lahir	*date*		
5	jenis_kelamin	*varchar*	15	
6	alamat	*varchar*	100	
7	no_telepon	*varchar*	14	
8	keys	*varchar*	15	
9	created_at	*timestamp*		
10	updated_at	*timestamp*		

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Table 2. Table of Books

No	Name	Type	Size	Key type
1	**no_induk_buku**	*varchar*	15	*Primary Key*
2	tanggal_masuk	*date*		
3	judul	*varchar*	100	
4	pengarang	*varchar*	100	
5	penerbit	*varchar*	100	
6	tahun_terbit	*varchar*	4	
7	kategori	*varchar*	35	
8	jummah	*int*	11	
9	lokasi_buku	*varchar*	50	
10	created_at	*timestamp*		
11	updated_at	*timestamp*		

Another database structure for the data used in the system is the borrowing table and the return table. **Table 3**. is the borrowing table structure. This table is used to store loan data. **Table 4**. The table is used to store return data. Here is the return table structure.

Table 3. Loan Table

No	Name	Type	Size	Key type
1	**no_peminjaman**	*varchar*	15	*Primary Key*
2	Tanggal	*date*		
3	is	*varchar*	25	*Foreign Key*
4	nama	*varchar*	75	
5	total_buku	*int*	2	
6	batas_pinjam	*date*		
7	created_at	*timestamp*		
8	updated_at	*timestamp*		

Table 4. Returns Table

No	Name	Type	Size	Key type
1	**no_pengembalian**	*varchar*	15	*Primary Key*
2	Tanggal	*date*		

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3	is	*varchar*	25	*Foreign Key*
4	nama	*varchar*	75	
5	total_buku	*int*	2	
6	total_denda	*double*		
7	created_at	*timestamp*		
8	updated_at	*timestamp*		

3.2 System Development Result

The system is equipped with a login menu for admin. This menu is used to log into the system by entering a username and password. To process the loan data, the system has a borrowing menu as we can see in **Figure 6.** Then to process the restore data, we can use the return menu as shown in **Figure 7**. This menu has some features for adding data, changing data, deleting data, printing data, detailing data, and searching for data.

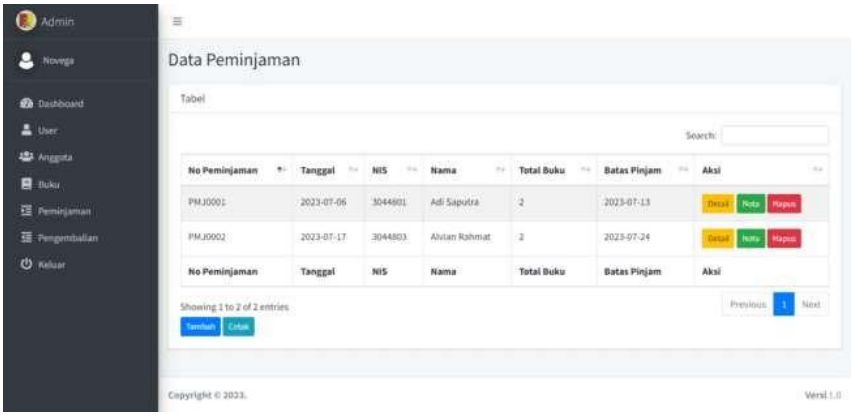


Figure 6. Borrowing menu

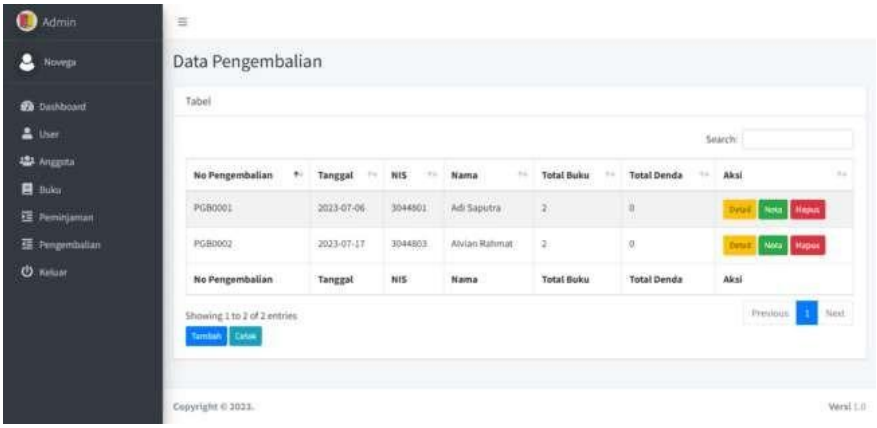


Figure 7. Return menu

Then, a restore menu is also made to process the return data as in Figure 8. This menu has many features, for example, adding data, changing data, deleting data, printing data, detailing data, and searching for data. The system can also generate a PDF file which consists of a loan data report as we can see in **Figure 8.**

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Figure 8. Loan data report

The report contains the number, loan number, date, nis, total book, and loan limit. A pdf file of the report for the return data can also be generated in the system. This report contains the number, number returns, nis, total books, and total fines. An example of pdf file content can be seen in **Figure 9.**



Figure 9. Return report

3.3 System Testing Results

The method used by researchers in testing this system is black box testing. Black box testing is software testing in terms of functional specifications without testing the code or the internal side of the program. That is, only the function, interface, and flow are tested without touching the code or script of the software. The results of the black box testing are described in **Table 5.**

Table 5. Black Box Testing Table

No	Menu	Result		Conclusion
		Normal	Error	
1	Menu *Login*	√		Normal
2	Menu Utama	√		Normal
3	Menu User	√		Normal
4	Menu Anggota	√		Normal
5	Menu Buku	√		Normal

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6	Menu Peminjaman	√	Normal
7	Menu Detail Peminjaman	√	Normal
8	Menu Pengembalian	√	Normal
9	Menu Detail Pengembalian	√	Normal

4. CONCLUSION

The conclusion of this study is to design and build a website-based library management system using HTML and PHP programming languages. The PHP framework uses Laravel. The CSS framework uses bootstrap. The database system uses MySQL. XAMPP and Visual Studio Code supporting applications. In designing using flowcharts, ERD, DFD level 0 and level 1. Testing the system using the black box testing method. The test results in system testing show that all features in the system run normally. Implementing a website-based library management system. The results of the implementation have been carried out by installing a library management system on the Madiun 6 High School library computer starting with the XAMPP installation and then installing the system.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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