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DEVELOPMENT OF HOSPITAL RESERVATION INFORMATION SYSTEM WITH UDC METHOD AND SUS TESTING

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Abstract *– Information system is a system that combines technology used to help human life. Not only helps facilitate information sistem activities, it also saves time, space and costs. Utilization of a website is useful in all fields because there are many and very broad and user-friendly features that can spoil the user's eyes. Activities that function to meet the needs of the general public are the meaning of public services as well as those related to other commodities such as goods, services and management provided by the organizers. In the health sector in public services, it is very necessary, especially in the service reservation process which still uses a queuing sistem in the form of taking queue numbers in the hospital lobby and waiting for hours, causing queues of visitors. The purpose of this study was to design a reservation information system at the hospital in order to increase the use of facilities and resources. The design of this hospital reservation information system is based on a website that was built using the user centered design method and tested using the SUS (Sistem Usability Scale) method which is in accordance with the criteria for the Sistem Usability Scale method which involves several respondents for information system acceptance.*

Keywords*: Information System, UDC, SUS, Hospital, Website*

I. INTRODUCTION

The increasing pace of development of computer technology, especially in the field of *software*, makes computers easier to use and a necessity for certain environments such as businesses. To do their job, they rely heavily on computers. nowadays computers are widely used to help make important decisions, such as information systems. An information system is a system that combines human activities and the use of technology to support management and operational activities. Along with the rapid development of technology, a number of applications were born to provide convenience and freedom for users in terms of time, place and cost. The Hospital Reservation Website utilizes information system technology that develops with a *website platform*. *The website* was chosen because the *website* has very wide features and is of course *user friendly*. The development of technology today, technology is utilized in the field of public services.

Public services are a number of activities within the scope of meeting the service needs of citizens and citizens for goods, services, and/or administrative services provided by public service providers. [1]. One of the public services is health services [2]. Improving public services in the health sector can be done by creating innovations in the form of *online* hospital reservations. Hospital *online* reservations are expected to be speeding up services thereby increasing hospital patient satisfaction [3].

In this study, the use of technology was used for hospital reservations. The reservation information system is a component that manages booking data which aims to make it easier for you to register. Research on the system for reservations has been carried out before by Sinaga & Samsudin (2021) with the results of a reservation website that implements the Laravel framework so that it is simpler and lighter in its use [4]. Further research by Husni & Putra (2019) with the results of the Hospital Management Information System which includes the application of a medical record driver's license [5]. Research conducted by Alkhaldi et al (2018) proves that the existence of online reservations can increase the use of facilities and resources [6]. The next research by Rahmatya et al (2020) with the results in the form of a reservation system that can store booking and payment data in *a database* and facilitate reporting [7].

The method used in creating a website in this study is the UDC or *User Centered Design* method, using this method can make it easier to build a website. This is proven based on existing research, such as: analysis on the sriwijaya university website [8], creation of the MGBK portal website[9], re-establishment of the web portal of the

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Department of Psychology FISIP[10], application film synopsis[11], for seminar applications[12], DMI Application Design[13] and many more.

The problemat this time is that the reservation service for a hospital provided is still ordinary or arguably still using the old way. namely, using a queuing system. visitors can make reservations anywhere, so visitors can know when they are going to the hospital. this can reduce the buildup and avoid complaints from visitors, besides this can speed up handling in the administrative department and reduce the operational costs of using hospital ATK.

II. RESEARCH METHODOLOGY

The following is a framework of the stages of research carried out.

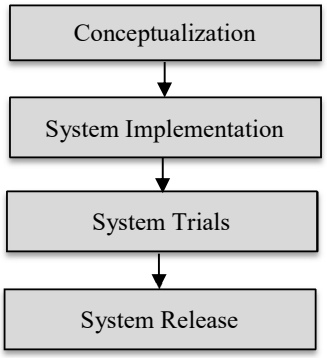

Figure 1. Research Framework

There are four stages in this study, namely:

1. Conceptualization
   Planning the big picture system will be made by digging and searching a list of topics by studying concepts that have existed from various valid sources such as books, journals, theses and dissertations. The resulting concept is in the form of system analysis and design, application design.
2. System implementation, the application of concepts that were previously made into a website-based *software* . The method used is UDC or User Centered Design. The UCD method is used because it presents the best approach if it outlines from the initial stages of an interactive process where design and evaluation steps are made from the beginning of the project to implementation [14] with stages such as the following:

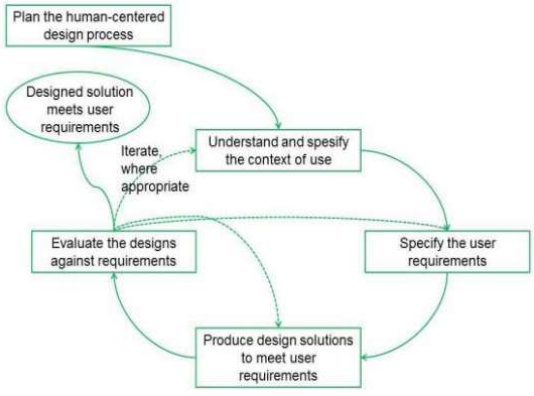

Figure 2. Stages of UDC

The process of *the User Centered Design* (UCD) Method has five processes, namely[15]:

a. *Plan the human-centered design process*, pthere this process we have to hold a discussion towards the people who will work on the project, to get a commitment that the process of building the project is user-centered or user-centered, It means that the project will have the time and task to involve the user or users in the beginning and end of the process or where they are needed. And also the people working on the project should know very well about the User method.
b. Understand Specifying the Context of Use, dasar of any UCD process is to understand the users of the intended product and their usage environment. Therefore, the typical UCD process begins with identifying users, It also includes all stakeholders, or indirect users, all those related to the system. At this stage also, we identify the characteristics of the user and the user group, Characteristics possible, following the iso definition, skills, education, age.
c. Specifying the User Requirements Basically at this stage is the stage of extracting information or data to collect the needs of the user, then after the information / data has been collected, the arrangement of information from the user's needs data is carried out, then the user's needs are described into various forms / techniques, such as narratives, images, or diagrams.
d. Produce Design Solution In this step, the first design was created. Sketches, mockups, simulations and other forms of prototypes are used to make ideas visible and facilitate efficient communication with users. This prevents the possible need and high costs associated with reworking the product at the next step of the life cycle. When design solutions are presented to the user, they should also be allowed to carry out tasks. The collected user feedback should be included in the design solution improvements. This should iterate continuously until the design goals have been met.
e. Evaluating The Design In subsequent activities, the design solution that was in the previous stage should be evaluated.. The goal is to generate feedback to further improve the product and to determine whether the design meets the specified user needs, usability goals and complies with general usability

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guidelines. The UCD process cycle continues as long as the usability goals have not been met.

3. System Trial, ensuring that the software created runs in line with user needs. Prose testing is carried out with SUS. The stages are as follows:

Figure 3. Stages of SUS

4. System release, introducing the system to *the user.*

III. RESULTS AND DISCUSSION

In the results and discussion section , several porses were carried out, while the process was as follows:

3.1 Planning

The planning stage is carried out an analysis of the needs of the system by the method of observation, from this stage results are obtained:

1. The flow of the hospital reservation system.
2. Analysis of customer profile and purchasing power.
3. Analysis of service and proximity to customers.
4. Analysis of the potential of the hospital.

3.2 Model Design Process

As for the modeling used is using UML, here is the diagram used:

1. *Use Case* Diagrams

From the results of the analysis, the needs of the system are made using a *use case* diagram, as shown in Figure 1.

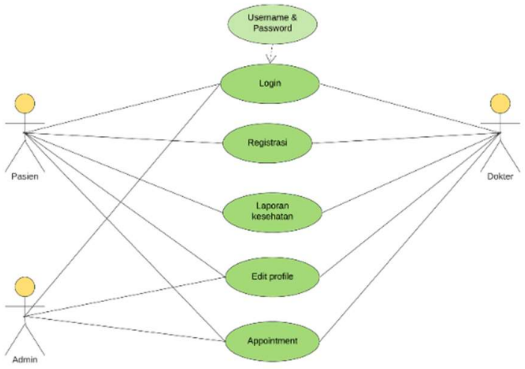

Figure 4. *Use Case* Diagrams

There are several *actors* and activities in figure 4.

a. Patient: The patient is the person who will visit the hospital, do health care.
b. Admin: The hospital officer who controls the recording of hospital reservations
c. Doctor: hospital staff who will check the patient's health at the hospital
d. Login: before accessing the *website*, there is a *login* activity by filling in the *username* and *password* obtained by registering
e. Registration: is an activity of registering on the *website* to get an account that can access the *website*
f. Health Report: patients who have done the examination, can see the results of the examination in the Health report which is filled out directly by the doctor who examined it.
g. Edit profile: *the website* account can be updated. Website *accounts* are individual. Patients can only edit their own accounts, as well as doctors but admins can edit patient accounts and doctor accounts
h. Appointment: is the main activity of online reservation. Patients will be presented on the day and time of the examination that is still available. The patient can choose the time and day of the examination. On the day and time of the examination, the patient who attends the examination to the hospital will be prepared by the admin and the doctor will know his patient to be examined.

2. *Class Diagram*

Here is a design analysis *of the Class Diagram* of the hospital Reservations application.

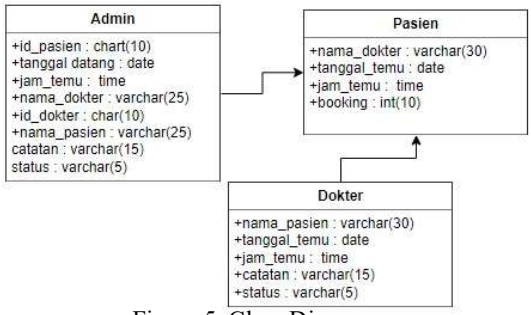

Figure 5. Class Diagram

Information:

There are 3 tables in the hospital Reservation including tb_admin, tb_pasien and tb_dokter all *indices* are connected to each other, in tb_admin *input* a *table* that goes to the tb_pasien, and tb_pasien input the *table* that connects the tb_dokter.

3. *Sequence Diagram*

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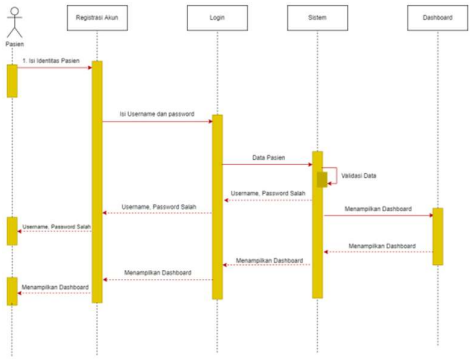

Figure 6. Patient *Sequence* Diagram

In the sequence diagram above, it is explained that there is one actor (patient) and four objects, namely account registration, login, system and dashboard. First of all the patient will be directed to the initial display to register / register an account by filling in the patient's identity. Then the patient is asked to log in by entering the username and password that have been previously registered. And the system will process, if the username and password are correct then it will enter the patient's dashboard to book the doctor.

4. *Statechart Diagram*

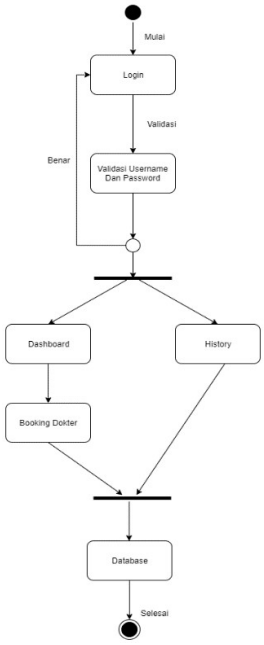

Figure 7. Patient Diagram Statechart

The statechart diagram above illustrates the doctor's booking system, where the first patient logs in if the username and password are correct, the patient will be directed to the main user display which contains a dashboard and history doctor's previous bookkeeping . On the dashboard menu, patients can directly book the available doctors and later the book history will go to the database.

5. *Deployment Diagram*

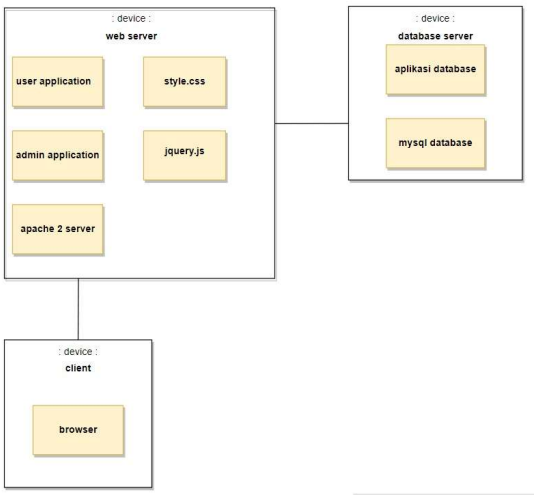

Figure 8. Deployment Diagram

The Deployment Diagram above shows that the website for the booking doctor device for the web server itself has a user application, admin application, apache 2 server, style.css and jquery.js. then for the database using a database application and mysql database while the device for the client to access can use a browser.

6. *Activity Diagram*

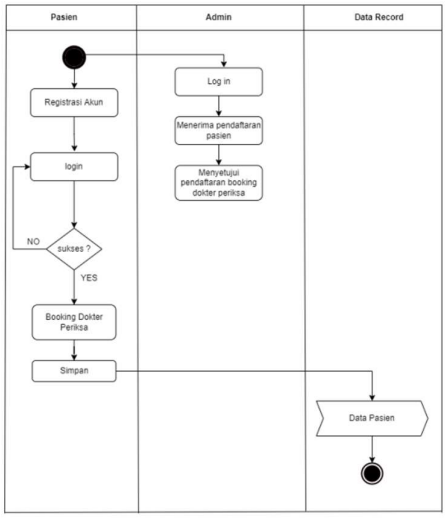

Figure 9. Activity Diagram

The diagram above is a visual form of the work flow that contains the activities or actions of patients and admins on the use of the website. Which in the first patient registers an account then logins, if the username and password are wrong, it will be directed back to the login menu, if the login is successful the patient will be directed to the dashboard menu to book a doctor. While in the admin, the admin will log in to approve the doctor's book and the booking data will be stored in the patient data / on the patient history menu.

3.2. Website Interface

Here is a look at the hospital reservation system.

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1. Page view via *admin user*

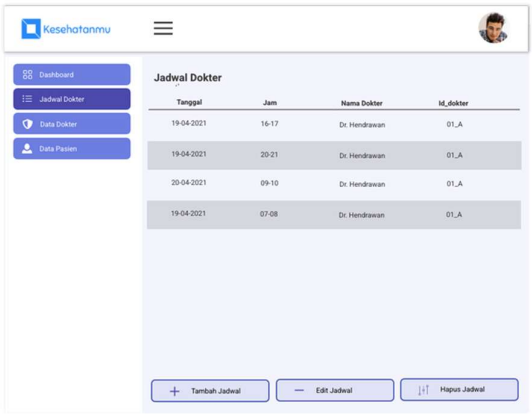

Figure 10. Admin

On the Doctor's Schedule menu in *the admin user* , there are several features that can be used, including adding a schedule, editing a schedule, and deleting a schedule whose results are contained in a table containing dates, hours, doctor names, and Id_dokter.

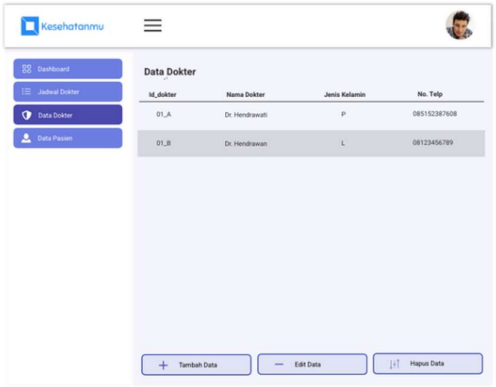

Figure 11. Physician data admin

On the Doctor Data menu in *the admin user* there are several features in the form of adding data, editing data, and deleting data whose results are contained in a table containing Id_dokter, Doctor Name, Gender, and Phone Number.

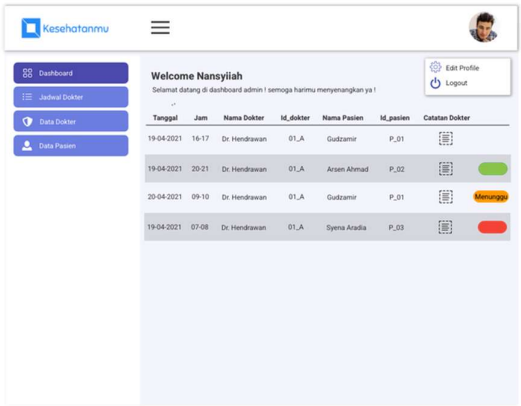

Figure 12. Admin dashboard

On the Dashboard menu in the admin user can display a table containing information about some patient status. The green color indicates the status is running, in *orange* it indicates the status is waiting, while the red color indicates the status is absent.

2. Page view through *patient user*

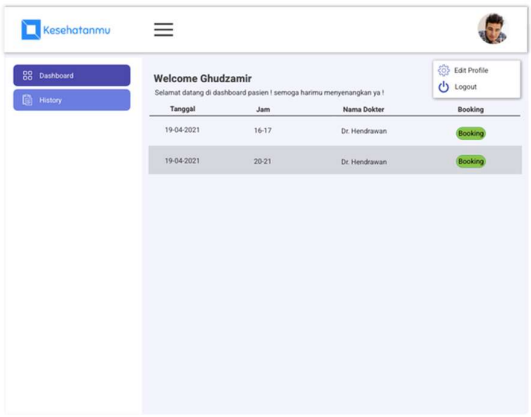

Figure 13. *user*

On the Dashboard menu, the patient user can display table information containing the date, time, doctor's name, and the status of the examination booking.

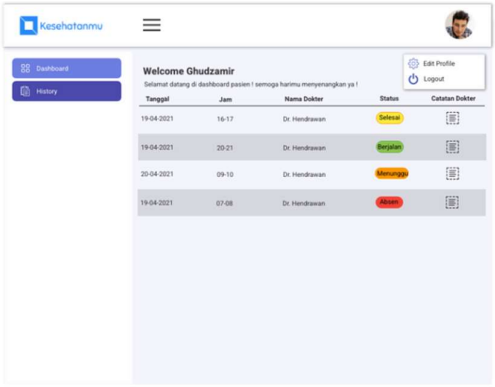

Figure 14. *user history*

On the *History* menu in the *patient user* can display examination history information containing the date, time, doctor's name, status, doctor's note.

3. Page display through *doctor user*

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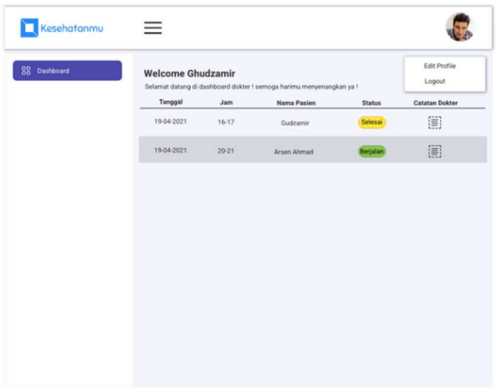

Figure 15. Doctor

On the Dashboard menu in *the doctor user* can display a table containing information on the date, time, patient name, status, and doctor's notes.

4. Initial Look

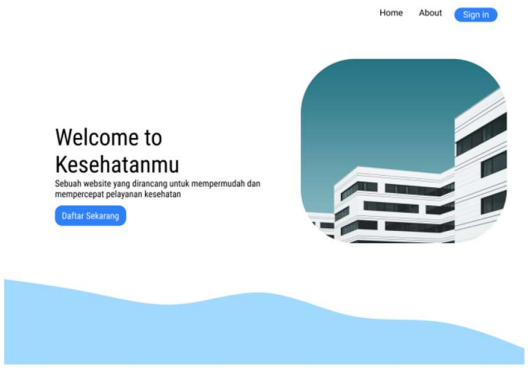

Figure 16. Initial view

In the initial display, there are *Home, About, Sign in*, and Register Now menus.

5. Login page display

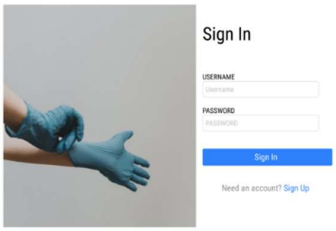

Figure 17. Login view

The *Sign in* display is a process to enter a *user* account that must fill in the *Username* and *Password* fields, then the user can press the *Sign in* button to enter.

6. Display of the account registration page

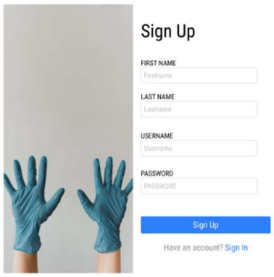

Figure 18. Account registration view

The *Sign up* display is a user registration process to be able to log in to an account, there are several things that must be filled in the existing fields, including *first name, last name, username*, and *password*. Then *the user* can press the *Sign up* button to create an account.

3.3. Sus Method Test Results

To measure the *level of usability* of a website system for the bookkeeping of doctors, an assessment is carried out using the SUS method. The following are the results of the SUS questionnaire ku e:

Table 1. SUS Test Results

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	Pembobotan
Responden 1	4	0	4	0	4	1	5	0	4	0	100
Responden 2	4	1	4	0	3	0	4	0	4	0	95
Responden 3	3	2	3	0	3	2	5	0	4	2	80
Responden 4	3	1	3	0	3	1	3	1	3	1	77.5
Responden 5	4	1	4	0	4	0	4	0	4	2	92.5
Responden 6	2	1	4	0	4	0	3	0	3	1	85
Responden 7	4	1	4	0	4	0	4	0	4	1	95
Responden 8	3	2	4	1	3	3	3	2	4	3	65
Responden 9	3	0	3	0	4	1	5	0	4	1	92.5
Responden 10	4	0	4	0	3	1	3	0	3	1	87.5
Score											**87**

From the calculation results using the SUS method on the examination doctor's bookbooking website, it gets an average score of 87 out of 10 respondents, it can be categorized as *acceptable* with *grade* B and this website is included in the *excellent* category acceptable to users

.

IV. CONCLUSION

This research, designing an online reservation website, visitors can make reservations anywhere, so that visitors can know when they are going to the hospital. this can reduce the buildup and avoid complaints from visitors, besides this can speed up handling in the administrative department and reduce the operational costs of using hospital ATK. By using the UCD method, the website development process is easier because it can adjust based on the wishes of the user. And by using testing with SUS, you can find out the calculation results with the SUS method on the hospital reservation website, this hospital gets an average value of 87 out of 10 respondents, it can be categorized as *acceptable* with *grade* B and this website is included in the *excellent* category that can be accepted by users.

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Travel Journal Application as an Android-Based Traveling Visitor Using Firebase

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Abstract* – Traveling is an activity that people do today to take a break from work, study or just enjoy the beauty of nature. But sometimes people forget whether they have visited a certain place. Photos in their gallery, which are not organized in their smartphone's internal storage and are not accompanied by a placemark, will cause someone to forget exactly what happened in a place. In this study, an Android-based application recording system will be designed to make the traveler who wanted to take photos during their vacation easy. This application uses real-time Firebase database features, Mapbox maps API, and GPS technology to differentiate between every photo was being taken. Firebase has the ability to automatically update changes made by one user to another and notify them simultaneously. This feature is useful for sharing happy moments with friends on the trip. And this application will send a reminder again when they visit a place not far from the one they are currently visiting.

Keywords: *Android, Travel Journal, Firebase, Mapbox Maps API*

I. INTRODUCTION

The rapid development of technology helps humans in carrying out their daily activities. Traveling to a tourist place or what is often called traveling can be considered an important need for everyone. Some people do it intending to release boredom from their daily routine, others want to enjoy the beauty of nature or learn about history. Someone may have visited a location, done various activities, and made many memories in the form of photos or videos at the location directly. Unfortunately, because a lot of locations have been visited as well as time reasons, these important files and data are not neatly organized or sorted on their phone's internal storage and are also not accompanied by a location marker at the exact location where the file was obtained, it will cause someone difficult to find about what's going on at that place. Manual search will obviously take a long time and is ineffective. So the data obtained is not valid and can be manipulated [1].

Similar research related to the development of a traveling support system in the form of a Tracking application is the Design of a Real-Time Touring Supporting Tracking Application System with a Case Study of the Trigramyama Motor Community Salatiga [2]. However, in this study, there was no feature to save travel photos, share photos, or detect the user's current location with tourist attractions that have been visited based on current coordinates.

Reliable cloud computing technology is needed to store data and communicate between users quickly. One of the cloud computing services that meet these criteria is Firebase. Firebase is a web application platform. Firebase stores data in JSON (JavaScript Object Notation) format [3].

GPS (Global Positioning System) technology has a big role in getting the coordinates of the current user. With GPS, the app gets the exact coordinates to store in the Firebase cloud database. GPS can also be used to detect whether the user is in an area close to the tourist attractions he is currently visiting. This ability to measure a location can be compared to the Euclidean distance measurement formula. Euclidean distance itself is a calculation to measure two points in Euclidean space which studies the relationship between angles and distances [4]. The formula and GPS technology are the main keys to this detection feature.

Based on this background, the authors designed the Travel Journal application as a recorder of users' traveling activities by utilizing Firebase cloud computing technology and GPS technology that is already available on the user's smartphone device.

II. RESEARCH METHODOLOGY

2.1 Travel Journal

Travel journal contains data/logs/travel of someone who stores location data, pictures, comments, etc., related to travel history data.[5]

2.2 Android

Is a mobile device with a Linux-based operating system and is designed for touchscreen devices. Its use is increasingly popular and more and more apps are made based on android.[6]

2.3 Cloud Computing

Cloud Computing is a computing method that exchanges data/resources via requests to the internet. The user will pay the price only several resources are used according to usage. The services provided by cloud computing providers usually also vary from Storage, Database, Virtual Server, etc. [7]

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2.4 Firebase

Is a Cloud Service that is mostly used to create applications that need real-time data exchange either on a website or mobile.[8]
Can be combined with various frameworks and exchange data via API in the form of JSON files. Synchronization is done in real-time and using a NoSQL database. [9]

2.5 JSON

JSON (JavaScript Object Notation) is the most common type of file/data used for exchanging data via the web using HTTP Requests, of type object and consisting of key and value pairs.[10]

2.6 GPS

The GPS navigation system (Global Positioning System) is a navigation satellite system that is widely implemented anywhere, one of which is on smartphones because it determines the position of objects using satellites and the Triangulation method.[11] This system was developed by the US Department of Defense and was originally used for military purposes. But now its implementation has expanded to the point where it can be used as a Maps service, directions, distance prediction, etc. This system is still used today when it comes to location and is still considered the most accurate at this time.[12]

2.7 Mapbox API

Is one of the API service providers, especially for the Maps service. The service itself is not inferior to the Google Maps API. The author chose to use the Service from this API because it tends to be easier to use and easier to integrate with the framework that I will use, namely the Lumen Framework. The pricing itself is also quite cheap, cheaper than Google Maps Service.[13]

2.8 SDLC Waterfall

Is the most common system development method used by software developers to develop their applications. This method is carried out systematically/structurally and sequentially.
This diagram itself has several phases starting from planning (planning), analysis (analysis), system design (design), implementation (implementation), testing (testing), and finally maintenance (maintenance). [14]

Figure 1 SDLC Waterfall Diagram

2.9 *Blackbox Testing*

A type of program testing/evaluation in which functionality testing is performed without detailed knowledge of implementation, code structure, and other internal parts. Testing is carried out completely based on the specifications and prerequisites of the program.[15]
This test is very subjective based on the perspective of the examiner / user. Unlike the developer team, these testers/users perform tests without having an idea of the program's structure and functionality to find out system weaknesses and errors. [16]

The system design method that the author uses is SDLC Waterfall, which goes through the following stages:

- *Planning*

Before developing a program, it is necessary to plan and collect the right requirements. In this stage, the system developer needs to communicate to understand the software requirements expected by the user and the limitations of the software. Information can be obtained through interviews, discussions, or field surveys.

- *Analyst*

After getting a fairly complete requirement, the developer needs to analyze the needs from a developer perspective, hardware requirements, software, database tables, etc.

- *Design*

At this stage, the developer begins to create a system design or prototype that can help both users and developers determine hardware requirements, system requirements and also an overview of the overall system architecture.

- *Implementation*

The system will begin to be developed in the form of modules or small programs called units. Each unit is developed and tested for its respective functionality which is commonly referred to as unit testing.

- *Testing*

System testing is carried out to verify and test whether the system can run according to system requirements according to limitations, testing can be done in BlackBox or Whitebox, and the tested modules can be categorized into unit testing (certain code modules), system testing (modules that are integrated with modules) other).

- *Maintenance*

This is the final stage, namely performing maintenance on software that is already running/deployed. Maintenance includes fixing errors/bugs not found in the previous step.

III. RESULTS AND DISCUSSION

The Travel Journal application has a variety of features that make it easy for users to save their memories at a certain tourist spot. So that users can use the application well, users can follow the following usage procedures:

1. Users register first to get an account to enter the Travel Journal application. The user needs to enter the desired name, date of birth, username, and password.

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Figure 2 Register Page

2. After getting a notification of successful registration, users can enter an account with their username and password. If registration fails, the user can re-register by paying attention to the identity that must be entered.

Figure 3 Login Page

3. The user will enter the main page in the form of a dashboard which is equipped with initial data in the form of the user's initial location and some previously stored user journal data (if any).

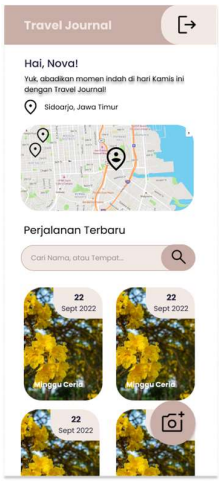

Figure 4 Dashboard Page

4. Application users can add data by pressing the plus button located at the bottom right of the application.
5. The application will open the phone's default camera capture window to take the first photo from the journal.

Figure 5 First Shot

6. After shooting the first image, the user will make improvements to the location tagging to ensure that the area from where the application shows is according to the latest GPS. As well as filling in journal data such as names and some special notes that are operational. Users can also add photos by pressing the same button on the bottom right of the application.

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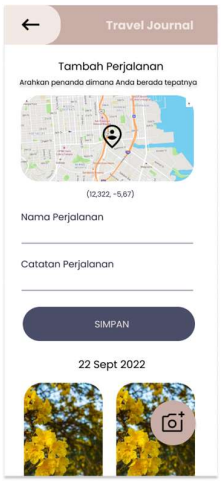

Figure 6 Add Data Page

7. The next page is optional, when the user has friends and wants to share the journal with his friends, the user can input the user based on his friend's name/username on the Add Friend page. So that the photo journal data will automatically be uploaded to the cloud, but if the user passes this process. then only data in the form of identity (text) will be sent to the cloud.

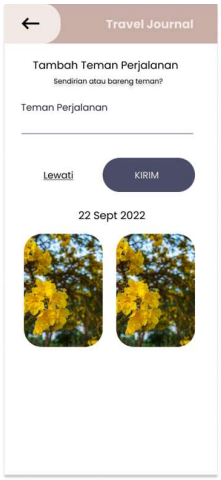

Figure 7 Add Friends Page

8. In the last step, after clicking the submit button, the user can review the journal that he saved through the main page and select his journal. Then a page will appear that displays the details of the stored memory data. On this detail page, users can also bookmark, rate, and share the location of the journal.

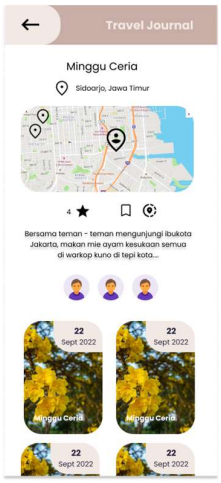

Figure 8 Journal Details Page

The Travel journal application has various features and to ensure the functioning of the application features, it is necessary to test using methods such as Black Box Testing. The following are the test results from the application which can be seen in table 1.

Table 1 The Result of Black Box Testing

No	***Test Case***	***Expected Output***	***Actual Output***	***Status***
A	**User Feature System**			
1	Register Account	Users can register using their name, username, password, and date of birth	User has successfully registered	√
2	Log In	Users can log in with their own username and password	The user is successfully logged in and can be redirected to the application start page	√

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3	Search Journal Location	User can search previously saved location	The user gets a map view with a marker at the location that matches the detailed data	√
4	Add Journal Data	Users can select a location by marking it, as well as enter the specified data	The user has successfully added data and it appears on the main page	√
5	Add friend	User can search for friends by username and add to journal	Friends can see the journal data in question	√
6	Journal Rating	Users can evaluate certain journal experiences	The user has successfully used the rating feature and there is a change in rating data	√
7	Journal Bookmark	Users can bookmark the journal to be included in the top journal	The user successfully sees the bookmarked data at the top after the journal is bookmarked	√
8	Log Out	User can exit the application	The user has successfully exited the application	√
9	Nearby Journal Notifications	Users get notifications when they pass by a place	User managed to get notification when passing forge	√

IV. CONCLUSIONS

The Travel Journal application is an application that helps users in dealing with the problem of managing and organizing media files in a disorganized smartphone gallery and adding reminders for users regarding any related activities in a place in the past. Various features have been designed to help automatically collect data to support the user experience of the application, such as automatic location detection based on GPS and automatic notification when the application is connected to the internet when a place has been previously saved based on the distance that has been defined. Suggestions from the author for the development of this application in the future:

1. Added features such as searching for famous tourist destinations nearby so that users don't have to link and fix map markers when adding a journal.
2. System and data privacy residing in the Firebase cloud should be moved to certain private servers.
3. Improved appearance of the application and fixes errors and bugs.

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Designing An Investment Learning App for Students Using Design Thinking Approach

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Abstract – Young people's awareness of stock investment is still low. Lack of knowledge about the investment stock market is an example of financial literacy. Moreover, the development of financial applications with game elements has created a new trend in the investment field. Therefore, we proposed a playful application as a learning medium to improve young people's stock market investment knowledge. This research aims to develop a mobile his application that can be used to improve the financial literacy, especially investment literacy, of Politeknik Negeri Batam students. The study uses a design thinking approach and leverages gamification to increase user retention. A total of 50 participants contributed to this study. Tracking, observing, and identifying problems that exist in the spread of financial literacy practices among Politeknik Negeri Batam students allows us to find new ideas as solutions to existing problems. The trial conducted on the product revealed that while users found the application overall useful and aligned with their requirements, there are still areas that need improvement.

Keywords – gamification, investment, stock

I. INTRODUCTION

Financial literacy is a basic need for everyone to avoid financial problems. Financial difficulties are not only caused by low income, but can also arise due to errors in financial management. Having adequate financial literacy is one of the important things to get a prosperous and quality life.

As a developing country, the awareness of young Indonesians towards financial literacy is still relatively low [1]. Financial literacy can be improved by educating the public in the financial sector intensively [2]. Efforts to educate the public, especially young people, are challenging, especially in finding the right way in the educational process. One of the factors that need to be considered in the learning process to improve financial literacy among young people is their individual learning style [3–5]. The right approach is needed so that the learning process becomes something fun and makes them engaged with the learning process itself.

In October 2021, IDX or PT Bursa Efek Indonesia (BEI) held a financial education program as well as asset management for young people to improve financial literacy, entitled FinanSiap. This step is an expansion of the previous program targeting young people as the largest retail investor group in the Indonesian capital market [6]. In addition to education through events, IDX is also active in socializing the importance of financial literacy on their online platform, both through their official website and social media sites. Currently, several financial institutions use gamification to increase financial literacy among young people [7]. Gamification is the process of using in-game mechanisms or rules on non-game activities with the aim of increasing user interactivity. The use of gamification is seen as a good opportunity that is worth trying to achieve the points that have been targeted by the IDX.

This study aims to increase the knowledge of young Indonesians, especially students, about good and correct finance by utilizing gamification through the creation of gamification applications that are intended for young people. The gamification technique in this study will be implemented through a mobile application. Previously, from August 2021 to September 2021, preliminary research was carried out through a literature review and a preliminary survey. The literature review is directed to obtain a theoretical basis for an appropriate application model to improve financial literacy among young people.

II. RESEARCH METHODOLOGY

We use design thinking method in this study. This method is known as a comprehensive thinking process that concentrates on creating solutions that begins with a process of empathy for a particular need that is human-centered towards an innovation. sustainable based on the needs of its users [8,9]. It was further explained that initially there were 3 stages consisting of inspiration, namely needs or problems that motivate the search for a solution or innovation, ideation, namely the process of generating ideas, developing and testing ideas, and finally implementation, namely finalizing the implementation to users. In its development, the three stages developed into 5 stages which are basically not much different but there is an emphasis on certain parts so as to produce more detailed procedures.

The first stage is Emphatize (Empathy) which is considered as the core of the human centered design process, this method seeks to understand the user in the context of the product being designed, by conducting observations, interviews, and combining observations and interviews with first. first given a scenario. The second stage is Define which is the process of analyzing and understanding various insights that have been obtained through empathy, with the aim of determining the problem statement as a point of view or main concern for research. The third stage is Ideate (Idea) which is a transition process from problem formulation to problem solving, while in this ideate process it will concentrate on generating ideas or

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ideas as a basis for making prototype designs that will be made. Fourth, Prototype (Prototype) is known as the initial design of a product to be made, to detect errors early and obtain new possibilities. In its application, the initial design made will be tested for users to obtain appropriate responses and feedback to improve the design. The last stage is the Test stage or testing is carried out to collect various user feedback from various final designs that have been formulated in the previous prototype process. This process is the final stage but is a life cycle so that it allows looping and returning to the previous design stage if there are errors.

III. Results And Discussion

Based on the design thinking method, the research was carried out by describing the problem in the framework of the method flow so that the design results were obtained that could overcome the main problems in this research.

a. Empathy. This empathizing stage includes observation, interviews and distributing questionnaires to prospective users to gain insight into the focus of research on investment and financial literacy among students.
b. Define. Based on the define process, it was found that the main problem that can be concluded from the results of the empathy process is the lack of information facilities that can inform the basics of investment and financial literacy among students. So the solution is to present alternative media in the form of mobile applications that are specifically designed according to target users who are able to facilitate the need for information exchange by utilizing internet technology. Furthermore, based on the data obtained, the specified target users are 19-25 years old and come from urban circles and are accustomed to using smartphones.
c. Ideate. The idea that will be made from the previous define stage is about how to produce a mobile application that is able to answer the problem of the difficulty of getting information about basic investment and financial literacy for students.
d. Prototype. From the process that was passed in the previous ideate stage, conclusions were obtained regarding various habitual flows carried out by students when they wanted to find out information about the basics of investment and financial literacy. The flow is then reformulated to become a flow that is used and used as a reference in designing the features that exist in this mobile application. Figure 1 shows a prototype that was successfully designed.

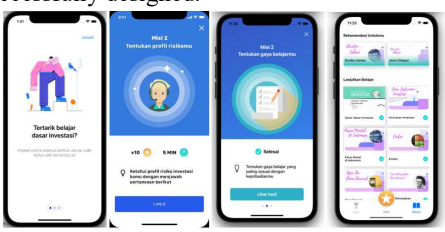

Figure 1. Prototype of miniVest

e. Testing. The last stage in this design thinking method, the author conducts a trial of the product produced at the previous prototype stage. Testing this application is done through two stages, namely by testing digital prototyping and questionnaires. Even though the target user thinks that overall this application is very useful and has met their needs, it still has some obstacles to be used as input and improvement. First, users need some time before getting used to using the application and understanding the features, icons and buttons that the application has. Second, according to users, the distance between the buttons does not match the thumb, as well as the size of the buttons that they still feel have not found the best format.

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IV. Conclusion

The result obtained in this study is a design model in the form of a mobile application on a smartphone which is a native mobile application, so that in future research if you want to perfect this design, you can consider doing a design in the form of a Hybrid mobile application where the application will be multi-platform that can consist of a combination of web design, mobile web, and native mobile applications themselves that are integrated with each other through separate research.

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A Study of Prediction Model for Capture Fisheries Production in Indonesian Sea Waters Using Machine Learning

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Abstract – The potential for capture fisheries in Indonesia is a priceless wealth. This wealth has not been explored optimally. Fisheries resources are included in the category of renewable resources whose sustainability needs to be considered. This is important in maintaining food security which will increase over time, due to population growth. Capture Fisheries Production Prediction Model is needed to find out what determining variables affect capture fisheries production. There are many methods for predicting, the method that is widely used today is using machine learning since it ability to handle complex jobs with large input data. This research is a literature study, which aims to: (1) identify and analyze machine learning methods that are suitable for predicting capture fisheries production, and (2) identify variables that can affect capture fisheries production. The results of the study show that the Neural Network method is most widely used as a predictive model. In addition, the Random Forest and Linear Logistics methods provide better accuracy results. The results of the study also succeeded in finding 12 determining variables for the capture fisheries production prediction model.

Keywords – Capture Fisheries Production, Machine Learning, and Prediction Models.

I. INTRODUCTION

Indonesia is the largest archipelagic country in the world. The great marine and fisheries potential is a priceless wealth [1]. However, this wealth has not been explored optimally, especially capture fisheries resources. Fisheries resources are included in the category of renewable resources, then the question often arises of how to maximize the potential of these fishery resources without causing negative impacts in the future. This is important in maintaining food security which will increase over time, due to population growth.

Sustainability is the key in fisheries development which is expected through wise management to improve the condition of resources and the welfare of the fishing community itself [1, 2]. The main problem is structure of capture fisheries in Indonesia that is still dominated by small-scale fishermen, this affects the amount of production of the main commodities. In addition, Illegal, Unreported and Unregulated Fishing (IUUF) is the biggest threat to the sustainability [3]. In fishing activities at sea, there are factors that can affect the number of catches [2, 4, 5, 7]. Thus it is necessary to know the factors that influence fisheries production. After knowing these factors, analysis and prediction of capture fisheries production can be carried out. This allows stakeholders to receive input to make plans and policies to increase production in this sector.

Prediction models are one of the strategies that are commonly used in most companies or organizations in the world to plan their work before it actually happens. The essence of forecasting is predicting future events based on past patterns and applying judgment to the projections. To carry out the assessment process with lots of data, we need a system that is able to predict in order to increase effectiveness. There are many methods for predicting, the method that is widely used today is using machine learning. Machine Learning can be used as a tool to analyze big data, find patterns in the past, to make predictions for the future. The Machine Learning method was chosen in this study because it can handle very complex jobs with large amounts of input data. This can offer a solution to predicting capture fisheries production.

The description of the problem and possible solutions above, made the writer interested in making it into a research. This initial research is a literature study, which aims to: (1) identify and analyze machine learning methods that are suitable for predicting capture fisheries production, and (2) identify variables that can affect capture fisheries production. This is expected to be a guideline for further technical research, in the use of appropriate model variables and also appropriate machine learning prediction methods. The results of this study in general are also expected to contribute to being a scientific reference for stakeholders in the field of capture fisheries to determine appropriate policies in order to improve the quality and quantity of sustainable capture fisheries production.

II. RESEARCH METHODOLOGY

This research is a literature study that summarizes some of the relevant literature on the prediction and analysis of capture fisheries production using machine learning. The stages in the research are as follows: literature identification, literature selection, method analysis and model determining variable analysis. The flowchart of the research stages can be seen in Figure 1.

The first step is to identify the literature through a search on the Crossref site. The keywords used in the

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literature search were "Machine Learning Prediction", "Productive Waters", and "Analysis of Capture Fisheries Production". After the literature is collected, literature selection is carried out. Literature is selected based on relevance and year of publication. The title of the literature is considered whether it is in accordance with the themes of "prediction with machine learning" and "analysis of capture fisheries production". Selection of the year of literature publication is limited from 2002 to 2022.

After selecting the literature by title and year of publication, the remaining literature was reviewed. The literature review includes its suitability with the research discussed and the availability of full text articles. Selected literature will be discussed in this study. Selected literature to be discussed is a minimum of 15 articles. The focus to be analyzed is the relevant method to be used and the determination of the research model variables.

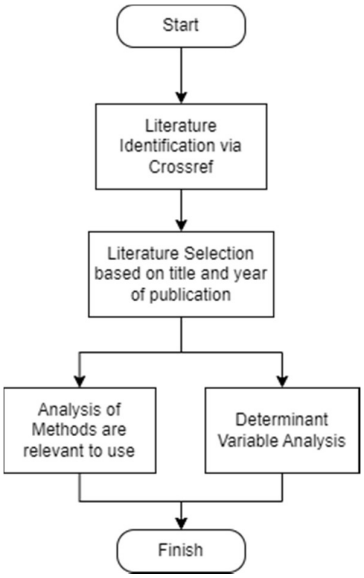

Figure. 1 Research Stages.

III. RESULTS AND DISCUSSION

Relevant primary literature that was successfully collected is shown in Table 1. This literature was chosen because it met the criteria in terms of relevance and year of publication. The total number of selected articles is 20 articles. There are 11 articles related to the machine learning prediction method. While the articles relating to the analysis of capture fisheries production are as many as 9 articles.

A. Machine Learning Method

The results of identifying the machine learning method for predictive analysis based on the collected literature are shown in Table 2. The results of identification based on the relevant literature collected show that the Neural Network method is most widely used as a tool for predicting various things with its determining variables, 10 times. After that follow the Logistic Regression method 2 times. While the Decision Tree, Linear Regression, Random Forest, SVM, and Naïve Bayes methods are also used as Machine Learning methods for predictive analysis. This literature study also shows the results that the Random Forest and Linear Logistics methods produce a better level of accuracy compared to Neural Networks [10] and [12]. A summary of the identification results of these methods is shown in Table 3.

The following is a brief review of the identified machine learning methods.

a. Neural Network.

Neural Networks are a type of machine learning process, called deep learning that uses nodes or neurons connected to each other in a layered structure that resembles the human brain. In this way, Neural Networks give computer programs the ability to recognize patterns and solve problems. Currently, this neural network model can be developed into Artificial Neural Networks, Convolution Neural Networks, and Recurrent Neural Networks [21].

b. Support Vector Machine

Support Vector Machine (SVM) is a method in supervised learning which is usually used for classification (such as Support Vector Classification) and regression (Support Vector Regression). In classification modeling, SVM has a more mature and clearer concept mathematically compared to other classification techniques. SVM can also solve classification and regression problems with linear and non-linear [22].

c. Logistic and Linier Regression

Regression models, including logistic regression, are data analysis methods that explain the correlation between a dependent variable and one or more independent variables. The goal of developing a regression model is to find the best-explaining relationship between these variables. The thing that distinguishes the logistic regression model from the simple linear regression model is that in logistic regression, the output variable is binary or dichotomous, so that the value of the dependent variable from the calculation results in the model will be mapped with a function to a binary value [22].

d. Random Forest

Random forest is a prediction algorithm which is a combination of several decision trees. This algorithm is quite computationally efficient because each decision tree randomly selects the variables used and does not use all the variables. The random forest model was built using the concept of bagging (bootstrap aggregation), namely collecting random sample observations into a container or called a bag. Some bags are composed of observations randomly selected from the original observational data in the training dataset. The dataset in the bag is formed from taking with returns which allows an observation result to have the opportunity to be re-elected [10].

e. Naive Bayes

Naive Bayes is a suitable method for binary and multiclass classification. This method, also known as Naive Bayes Classifier, applies supervised object classification techniques in the future by assigning class labels to instances/records using conditional probabilities. Conditional probability is a measure of the probability of an event occurring based on other events that have (with assumptions, presumptions, assertions, or proven) occurred [22].

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Table 1. List of Primary Literature.

Author	Theme Category	Method
[1]	Fisheries Production Results	Regression Analysis
[2]	Sustainability of Capture Fisheries	Rapfish Technique (Rapid Appraisal for Fisheries).
[4]	Capture Fisheries Prediction with Data Mining.	Comparison of Decision Tree, Naive Bayes, SVM, and Neural Network.
[5]	Yellow Fin Tuna Fishing Area.	Remote Sensing, Geographic Information Systems, and Linear Regression.
[6]	Mackerel Fishing Area	Remote Sensing and Geographic Information Systems.
[7]	Fisheries Production	Cobb-Douglas production function.
[8]	Stock Predictions with Deep Learning.	Hidden Layer Neural Network.
[9]	Comparison of Exchange Rate Prediction Models During the Pandemic	Comparison of Neural Networks, Genetic Algorithms, and Particle Swarm Optimization
[10]	Fish Catchment Zone Prediction	Remote Sensing and Geographic Information Systems
[11]	Prediction of Students Graduated Not on Time	Neural Network Backpropagation
[12]	Delivery Prediction with Machine Learning	Comparison of Random Forest, artificial neural network (ANN), and logistic regression.
[13]	Prediction of Number of Aircraft Passengers	Neural Network Backpropagation
[14]	Capture Marine Fishery Production	Cobb-Douglas production function.
[15]	Stock Prediction	Neural Networks, and Particle Swarm Optimization
[16]	Rice Production Prediction with Artificial Neural Network.	Artificial Neural Network Backpropagation
[17]	Hotel Cancellation Predictions	Comparison Logistic Regression and Artificial Neural Network
[17]	House Price Prediction with Machine Learning.	Linear Regression
[19]	Pelagic Fisheries Capture Production.	Multiple Linear Analysis.
[20]	Capture Fisheries Production	CPUE Analysis, Scoring, Location Quotation.
[21]	Stock Price Prediction with Recurrent Neural Network	Recurrent Neural Network

f. Decision Tree

Decision tree is a structure that is used to assist the decision-making process. Called a "tree" because this structure resembles a tree complete with roots, trunks, and branches. In data science, a decision tree structure can help make effective decisions while still paying attention to the possible results and consequences [22].

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Table 2. The identification results of the machine learning method.

Author	Machine Learning Method	Result
[4]	Decision Tree, Naive Bayes, SVM, and Neural Network	The application of the Decision Tree, Naive Bayes, SVM, and Neural Network algorithms in the case of predicting an increase in the average volume of capture fisheries is quite good. The Neural Network Algorithm has the highest accuracy value.
[8]	Hidden Layer Neural Network	The challenge in processing Deep Learning (DL) data is determining the epoch parameter values to produce high accuracy predictions.
[9]	Comparison of Neural Networks, Genetic Algorithms, and Particle Swarm Optimization	The results showed that the performance of the optimization algorithm (Genetic Algorithm, and Particle Swarm Optimization) in increasing the Neural Network error rate was the same, namely 0.020 +/- 0.006.
[11]	Neural Network Backpropagation	Data mining techniques using neural network backpropagation can produce a precise and accurate prediction from previous research to determine students graduating not on time at State Vocational High School 1 Kertak Hanyar.
[12]	Random Forest, artificial neural network (ANN), and logistic regression.	The random forest method produces a better accuracy value when compared to the logistic regression and artificial neural network (ANN) method, which is 76.6%, while the ANN method and logistic regression are 73.81% and 72.84%.
[13]	Artificial Neural Network Backpropagation	The level of accuracy reaches 88.14% or with a relatively low error rate of 11.86%.
[15]	Neural Network Backpropagation	Predictions using the Backpropagation Neural Network method produce good predictions with a MAPE of 19.77%. The prediction for the number of passengers in the next period, namely May 2022, is 1,060,500 passengers.
[16]	Neural Networks (NN), and Particle Swarm Optimization (PSO)	By using NN, the results of the experiments carried out with the Neural Network 500 training cycle, 3 Hidden layers, Momentum 0 and Learning rate 0.2 get 0.466 rmse. Meanwhile, the results of the NN experiment with PSO or PSO-NN feature selection yielded 0.373 rmse. This PSO-NN-based research is able to predict more accurately.
[17]	Logistic Regression and Artificial Neural Network	From the five trials, the fifth experiment (logistic regression with GridSearchCV) is the most optimal method for predicting hotel booking cancellations, with an accuracy value of 79.77%, a precision value of 85.86% and a recall value of 55.07%.
[18]	Linear Regression	Using 80% of the dataset for training and 20% of the dataset used for testing produces output values with an accuracy rate of 88% in predicting.
[21]	Recurrent Neural Network	Prediction of seven variable features with RNN produces an accuracy of 94% for training data and 55% for test data. Accuracy is obtained after training using 1218 data.

Table 3. Summary of Machine Learning Method Identification Results.

No	Method	Quantity
1	Neural Network	10 (ten)
2	Logistic Regression	2 (two)
3	Linear Regression	1 (one)
4	Random Forest	1 (one)
5	SVM	1 (one)
6	Naïve Bayes	1 (one)
7	Decision Tree	1 (one)

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B. Fisheries Production Model Variables

The results of the identification of the capture fisheries production model variables based on the collected literature are shown in Table 4. The identification results based on the collected relevant literature managed to find 12 variables that determine the capture fisheries production model (Table 5). The number of boats, the number of fishermen, and fishing gear are the most frequently encountered variables, the more boats and also the number of fishermen in an area, of course, will also increase capture fisheries production. Fishing gear also affects fisheries production, adequate fishing gear technology will make it easier for capture fisheries.

Sea Surface Temperature and Chlorophyll-a also affect the productivity of the waters. Usually productive waters have low surface temperatures and high amounts of chlorophyll a, this is related to the upwelling phenomenon. Illegal fishing practices and legal aspects can also affect capture fisheries production in an area. Other factors that may be used as a model variant are type of boats time at sea, fishermen's income, wind speed, amount of rainfall and number of rainy days.

Table 4. The identification results of the machine learning method.

Author	Independent Variable	Dependent Variable	Result
[1]	Number of Vessels, Number of Fishermen	Fisheries Production Results	Number of Vessels and Number of Fishermen together affect Fisheries Production.
[2]	Ecology (Catch), Social (Quantity and Quality of Fishermen), Economic (Revenue of Fishermen), Technology (Vessels and Fishing Gear), Law and Institutions (Illegal Fishing, Law Enforcement Personnel, Regulations).	Sustainability of Capture Fisheries	Ecological conditions are the worst aspects, technological aspects are the most differentiated, and integration between or across aspects is an important thing.
[5]	Sea Surface Temperature, Chlorophyll-a	Yellowfin Fish Catches.	The distribution of SST and chlorophyll-a did not significantly affect the catch of yellowfin tuna in the waters of Aceh Province.
[6]	Sea Surface Temperature, Chlorophyll-a	Mackerel Catches	Bangka waters are suitable as an estimator of potential mackerel fishing grounds. The distribution of fishing grounds is not only in waters close to the fishing base (PPN Sungailiat), but also in waters far enough from the fishing base.
[7]	Fuel, time, distance, number of ships, number of crew, distance, fishing gear.	Fisheries Production	Significant factors are time, vessel and fishing gear. Meanwhile, the insignificant factors were diesel fuel, number of crew members, and distance.
[10]	Sea Surface Temperature, Chlorophyll-a	Fish Catch	The fishing potential zone in Aceh Jaya waters was only detected in November and December. This is due to the high distribution of chlorophyll-a and the presence of sea surface temperatures suitable for fishing in that time period.
[14]	Types of Boats, Number of Boats, Types of Fishing Gear	Capture Fisheries Production	Adequate marine fishing fleets and equipment are needed to increase marine capture fisheries production in Aceh Jaya District.
[19]	Wind Speed, Total Rainfall, Number of Rainy Days.	Catches of Cob, Mackerel, Squid.	Wind speed is significant for squid and cob catches. The amount of rainfall and the number of rainy days are significant for mackerel catches.
[20]	Historical Fish Catches, Fishing Equipment, Illegal Fishing.	Capture Fisheries Production	Strategic steps needed: increasing the capacity and reach of the fishing fleet, effective efforts to prevent illegal fishing practices, construction of fishing ports that are directed to become the basis of fishing efforts and improving the quality of human resources.

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Research on machine learning methods requires the availability of relatively large amounts of historical or time series data. This is supported by the results of research [21] which stated that good accuracy in his research was achieved after training using 1218 data. In further technical research, perhaps these determining variables need to be re-selected based on the availability of time series data.

Table 5. Results Summary of the Identification of Fisheries Production Model Variables.

No	Independent Variables / Determinants	Quantity
1.	Number of Boats	4 (four)
2.	Fishing Gear	4 (four)
3.	Number of Fishermen	3 (three)
4.	Sea Surface Temperature	3 (three)
5.	Chlorophyll-a	3 (three)
6.	Illegal Fishing and Other Legal Aspects	2 (two)
7.	Types of Boats	1 (one)
8.	Time to Go to Sea	1 (one)
9.	Fishermen's Income	1 (one)
10.	Wind velocity	1 (one)
11.	Number of Rainy Days	1 (one)
12.	Total Rainfall	1 (one)

IV. CONCLUSION

The results of the study show that the most widely used method for prediction models with Machine Learning is Neural Network. The Random Forest and Linear Logistics methods also need to be considered for further technical research in this regard, because they provide better accuracy results than the Neural Network method. It is hoped that further technical research will be able to use these methods as tools and also conduct comparative studies of some of these methods on capture fisheries production prediction models.

The results of the study also succeeded in finding 12 determining variables that could be used for the capture fisheries production prediction model with Machine Learning. These variables include: Number of Boats, Fishing Gear, Number of Fishermen, Sea Surface Temperature, Chlorophyll-a, Illegal Fishing and Legal Aspects, Types of Boats, Time to Go to Sea, Fishermen's Income, Wind Speed, Number of Rainy Days, and Total Rainfall. Further technical research, these determining variables need to be re-selected based on the availability of time series data.

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The Impact of Digital Promotion, Product Quality, Product Price, and Business Location on Purchase in MSMEs in The Coastal Region

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Abstract – This study aims to examine the influence of digital promotion, product quality, product prices, and business location on purchasing decisions for products produced by micro, small, and medium enterprises (MSMEs) in Pabean Udik village, Indramayu district. Pabean Udik village is located in a coastal area with relatively low levels of education and technological literacy. The study population includes MSME actors, community members, and stakeholders in the village. The measurement scale used is a Likert scale. If the model includes intervening or moderating variables, it can be analyzed using path analysis. Path analysis allows for the examination of direct and indirect relationships between variables. The analysis will help in making decisions based on hypothesis testing. The findings show that product quality has a positive effect on purchase decisions, product price does not significantly influence purchase decisions, digital promotion has a positive effect on purchase decisions, and business location does not significantly influence purchase decisions. Additionally, product quality, through business location, has a positive effect on purchase decisions, and product price, through digital promotion, also has a positive effect on purchase decisions. Digital promotion has the strongest influence on customers' purchasing decisions. To enhance the competitiveness of MSMEs in coastal areas, it is recommended to utilize digital promotions through platforms such as WhatsApp and Facebook. Additionally, programs for improving the digital literacy and skills of MSMEs' human resources are recommended to better adapt to social media and digital platforms. The aim is to increase their positive competitiveness in the market.

Keywords – digital promotion, product quality, product price, purchase decisions,* Pabean Udik *village

I. INTRODUCTION

Current technological developments are pushing all business sectors to transform, switching to digital marketing [1](Gretzel, 2000). Marketing is the heart for anyone as a business person. A marketing strategy that is able to adapt to current customer needs and behavior that determines the existence of a business[2]. Business people must be agile in adapting the marketing strategies they use[3]. Digital marketing is currently a marketing medium that is widely used by business people due to changes in the character and habits of customers. Observations made on MSMEs Pabean Udik village whose position is in the coastal area obtained conditions that are the focus of attention so that MSMEs products can be recognized and sell well in the market[4]. MSMEs products in Pabean Udik village have various variations such as types of food, handicrafts, products sourced from mangrove trees. Apart from digital marketing, there are several other variables that are very important to confirm, such as product quality, pricing that is affordable and in accordance with the value of the product, and business locations that are representative and easy for customers to find.

These variables will influence buying decisions from customers and of course if the business conditions in the area are getting better, the economic level of the community will also be getting better. The uniqueness of this research is to discuss the variables that influence customer buying decisions for coastal communities. MSMEs actors in Pabean Udik Village are dominated by generations who have low IT literacy, while the community as customers are dominated by productive age with better IT literacy. The local government has made various efforts to introduce unique products to Pabean Udik village in various ways through regional and national events.

The results indicate that product quality has a significant positive impact on purchase decisions[5]. However, product price and business location do not significantly influence purchase decisions. On the other hand, digital promotion has a significant positive effect on purchase decisions [4]. Additionally, the mediating effect of product quality on the relationship between business location and purchase decisions do not significantly. Similarly, the mediating effect of product price on the relationship between digital promotion and purchase decisions is found to be significant.

These findings provide valuable insights into the factors influencing purchase decisions and highlight the importance of product quality and digital promotion in influencing consumers' buying behavior."

The results of this research are expected to be a guide and reference for regions with similar conditions to develop the potential of their regional products through the application of technology.

II. RESEARCH METHODOLOGY

This research was conducted in a coastal area at Pabean Udik Village, Indramayu district. This study examines how the dependent variable Purchase Decision of MSMEs customers is influenced by four independent variables: Product Quality, Product Price, Digital Marketing, and

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Business Location. The research consists of 6 hypotheses that will be tested, examining how product quality, product price, business location, and digital marketing influence purchase decisions. The following table presents the hypotheses for this study:

Table 1: Research Hypotheses

No.	Hypothesis
1.	H1: Product Quality (KP) has a positive effect on Purchase Decisions (KM)
2.	H2: Product Price (HP) has a significant effect on Purchase Decisions (KM)
3.	H3: Digital Promotion (PD) has a positive effect on Purchase Decisions (KM)
4.	H4: Business Location (LU) has an influence on Purchase Decisions (KM)
5.	H5: Product Quality (KP), through Business Location (LU), has a positive effect on Purchase Decisions (KM)
6.	H6: Product Price (PP), through Digital Promotion (PD), has a positive effect on Purchase Decisions (KM)

This study uses a structural equation modeling method that focuses on predictions and describes the model concept with latent variables (variables that cannot be measured directly) but are measured through their indicators (manifest variables). The reasons for using SEM-PLS as an analytical method in this study are:

The variables used in this study are latent variables

The form of the research model built is simultaneous with X and Y multi-variables.

To explain the relationship between direct and indirect latent variables mediated by intervening variables.

The processed data is also relatively small

Structural Equation Modeling (SEM) is a statistical technique that is able to analyze latent variables, indicator variables, and measurement errors directly. With SEM we are able to analyze the relationship between latent variables and their indicators (Outer Model), the relationship between one latent variable and another latent variable (Inner Model), also know the magnitude of measurement error. In addition to unidirectional causal relationships, SEM also allows us to analyze two-way relationships that often appear in the social and behavioral sciences. If a model is formed using intervening or moderating variables, we can complete it with path analysis. Path analysis allows us to examine direct and indirect relationships between variables and models. Path analysis will make a decision with the results of the hypothesis test, if the t-value > 1.96 and p-value < 0.05 then hypothesis 0 (H0) is rejected and the alternative hypothesis (H1) will be accepted.

III. RESULTS AND DISCUSSION

The research hypothesis mentions several relationships and the influence of the independent variables on the dependent variable (Purchasing Decision).

3.1 Demographic Data

The research includes respondents from various backgrounds and demographics. The sample for this study consists of individuals residing in Pabean Udik village, Indramayu district, which is located in a coastal area with relatively low levels of education and technological literacy. The respondents were selected using a combination of random sampling and purposive sampling techniques. The random sampling method was used to select individuals from the community who represent the general population of the village. The purposive sampling method was employed to target MSME actors and stakeholders who have direct involvement in the local business activities.

The demographic characteristics of the respondents include age, gender, education level, occupation, and experience in the local market. These variables were considered to ensure a diverse representation of the community and capture a comprehensive understanding of the factors influencing purchase decisions in the coastal region. The total number of respondents in this study was 80, with a balanced distribution across different demographic groups. The data collected from the respondents were analyzed using appropriate statistical techniques to test the research hypotheses and draw meaningful conclusions.

From the respondents (community groups) as customers who used the sample, data were obtained with the percentage of educational qualifications as follows:

Table 2: Qualifications of Respondents (MSME customers)
.

No.	Characteristics	Category	Amount/%
1.	Community Group	Customer	80
2.	Formal education	primary school Junior high school	56%
		Senior High School	36.25%
		Bachelor	7.5%

From the qualification data, it can be said that the community group referred to as MSMEs customers is dominated by people with elementary/junior high school education (56%). Respondents from the MSMEs actor group by looking at the conditions for utilizing technology platforms as their digital marketing media can be seen as follows:

Table 3: Utilization of Technology Platforms as Digital Marketing Media

No.	Characteristics	Category	Lots (Person)
1.	Community Group	MSMEs	66
2.	Social Media Ownership	WA	100%
		Facebook	30.3%

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		Instagram	0%
3.	Business Page Ownership	Website	0%

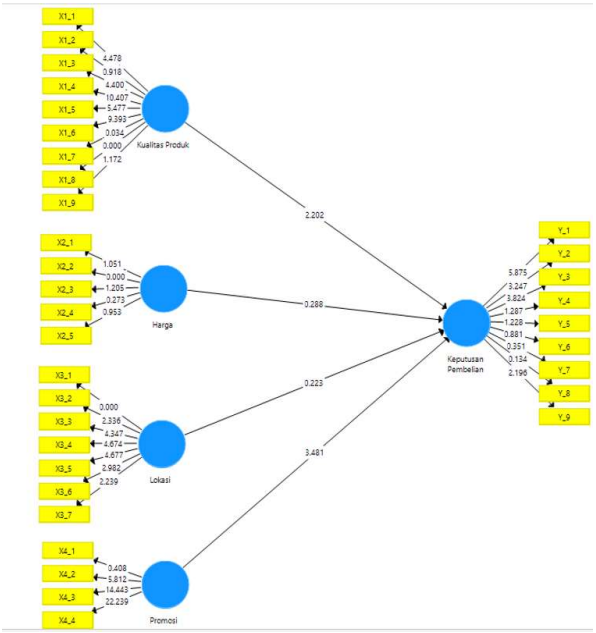
From the data on the utilization of these technology platforms, it can be said that MSME actors in coastal areas are still dominated by the use of WhatsApp and Facebook, while other media have not been empowered in their business.

3.2 Path Significance Test

In addition to the significance test for indicators in the bootstrap result variable, we can also use it to test the significance of the path between latent variables. The test results are presented in the following table, the results of the path significance test indicate that there are several alternative hypotheses that do not meet the criteria.

Table 4: Path Significance Test

No.	Track	p-values	t-value	Path Significance Test (t-value > 1.96)
1	KP >> KM	0.022	2019	Significant
2	HP >> KM	0.068	1,495	Not significant
3	PD >> KM	0.000	3,448	Significant
4	LU >> KM	0.466	0.085	Not significant
5	KP >> LU >> KM	0.466	6,932	Not significant
6	HP >> PD >> KM	0.000	6,964	Significant



Figures 1: Path Significance Test

The findings of the SEM PLS analysis based on the figures 1 are as follows. From the available figures, it can be observed that Product Quality has a significant positive influence on purchase decisions (indicated by the positive and significant path coefficients). However, Product Price does not have a significant effect on purchase decisions (indicated by the non-significant path coefficient). Similarly, Business Location does not have a significant impact on purchase decisions (indicated by the non-significant path coefficient). On the other hand, Digital Marketing has a significant positive effect on purchase decisions (indicated by the positive and significant path coefficient). These findings suggest that Product Quality and Digital Marketing play crucial roles in influencing consumer purchase decisions, while Product Price and Business Location do not significantly influence purchase decisions.

IV. CONCLUSION

Digital Marketing has the strongest influence on determining buying decisions from customers, through secondary data obtained from questionnaires for people of productive age in coastal areas, stating that most of their people use the WhatsApp messaging application (100%) and Facebook social media 30.3%. Thus, in order to increase positive competitiveness for MSMEs in coastal areas, it is recommended to use digital marketing by creating content and product promotion through the WhatsApp messaging application and Facebook social media. In order to increase business potential and expand the reach of promotions and build brand awareness of MSMEs products in coastal areas, it is recommended to create a competency improvement program for MSMEs human resources to better adapt social media and digital platforms

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The Selection of Outstanding Teacher Analysis at SD Negeri 01 Perigi Using TOPSIS Method

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Abstract – Teacher is an important part in the process of teaching and learning activities with students. A teacher can be declared an achiever if he is able to complete the assigned task charged such as: teaching in class, personality and attendance. At the moment, SD Negeri 01 Perigi has 25 permanent teachers, and usually to chose the best teacher candidate uses a subjective judgments standards which is based on the closeness of teacher personnel. For this reason, further analysis is needed to overcome the subjectivity of the procedure selection of outstanding teachers by the principal as the decision maker. TOPSIS method is used to solve the problem . The TOPSIS method will rank the final results of the selected alternatives which calculate the positive ideal distance and negative ideal distance. Criteria set at this research is used as a weighting that is Teacher Evaluation Value, Absence, Discipline, Technology Proficiency, Learning Innovation, and Pedagogic then matrix calculations are carried out which will produce the ranking order that will be selecting the best alternative from a number of alternative solutions. The results of this research are produced 10 sequences outstanding teachers in the order of Wahyuni Fitri Anita (0.923838), Arbaini (0.828896), Abdul Qodir(0.789324), Panji Wahyu Utomo (0.779973), Tuti Supriyati (0.777795) , Rista Milla Karmella (0.773156), Een Wahyuni (0.756624), Nita Susanti (0.697743), Syifa Habibah(0.666821), and Riana Arista(0.62586). The use of the TOPSIS method can assisting the Principal of SD Negeri Perigi 01 in providing recommendations for selection of outstanding teachers objectively at SD Negeri Perigi 01.

Keywords – Decision Support System, TOPSIS, Outstanding Teacher Selection

I. INTRODUCTION

A teacher is a professional educator with the main task of educating, teaching, guiding, directing and evaluating students in early childhood education through formal education, primary and secondary education. The role of the teacher is very influential on the smooth teaching and learning of students. In providing teaching and education to students, a teacher must have a special way so that the teaching given can be accepted and able to be captured by students. In providing material, teachers are required to be able to open their students' insights and enthusiasm for learning both online and offline and the teacher must always monitor students in detail and precisely so that students can easily understand the material presented by the teacher [1]. The burden of a teacher is very heavy because he is a figure that must be emulated by students who play a very important role in the process of building the civilization of a nation with graduates of quality and good morals.

As an effort to give awards to teachers, schools certainly need to give awards to outstanding teachers who have contributed their thoughts and energy, and as a means of competition for teachers to be able to maintain and improve their performance at school.

This research was conducted at SD Negeri 01 Perigi South Tangerang, where based on interviews with the school, that so far the school does not have certain and standard assessment criteria for deciding teachers who excel in school, decision-making in the assessment is still based on subjectivity, namely based on the recognition factor only socially and closeness factors, so that this can motivate other teachers. For this reason, a solution is needed to overcome this problem, namely by analyzing the TOPSIS method to determine outstanding teachers, where the final results will provide a rating recommendation from outstanding teachers based on the weight value of the criteria used in the calculation. The method used in this study is the Technique For Order Of Preference By Similarity To Ideal Solution (TOPSIS), where this method results in a decision making with a multi-criteria problem approach with the results of the selected alternative solutions must be seen from the solution factor the closest positive distance and the farthest negative distance in order to get the best alternative solution and TOPSIS has a better level of accuracy compared to some of its predecessor methods [2]. The TOPSIS method was chosen as the method in this study because according to several previous studies it was stated that the TOPSIS method was suitable and could be implemented to provide recommendations for the best teachers in schools[3],[4],[5]. Previous research discussed about teacher evaluation based on performance using the TOPSIS method. The problem in this study lies in teacher assessment so far being subjective so a system is needed to overcome it. The results of the application of TOPSIS stated that TOPSIS could be used as a tool in making decisions about the best teacher[6],[7]. The second research discusses the selection of tertiary institutions using the TOPSIS method, where the problem raised in this study is the selection of tertiary institutions for high school students as prospective students where most of the selection of tertiary institutions is only based on the words of friends or even just following friends so the authors conducted research related to this problem. The results of applying TOPSIS in this study state that the TOPSIS method can fulfill the objectives because the calculation results can assist prospective students in choosing a tertiary institution[8]. Follows by research about choosing the right land for oil palm plantations using the TOPSIS method [9]. The problem in this research is to find the right land for oil

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palm plantations so that the planted oil palm plants can grow optimally so that they can produce high quality coconut oil. The result of applying TOPSIS in this study is that the TOPSIS method can produce the best alternative based on the shortest distance from the positive ideal solution and the farthest from the perfect negative solution. Another study discusses the selection of outstanding teachers at SMK Negeri 1 Pantai Labu using the TOPSIS method[10]. In this study the authors conducted a ranking in finding outstanding and underachieving teachers using the TOPSIS method. Based on the calculation of the criteria weight, it can be concluded that the TOPSIS method can be used in an effort to determine outstanding and underachieving teachers. Research of an assessment of the best employees at the Hidayah Purwokerto General Hospital using the TOPSIS method[11]. The test results from this study indicate that TOPSIS can be implemented in determining the best employees.The sixth research discusses the acceptance of new employees at SMA Al Waliyah Tanjung Morawa [12],[13],[14]

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II. RESEARCH METHODOLOGY

2.1Research Data Collection Method

According to Sugiyono[15] one of the techniques that can be used in collecting data is to collect primary data. Primary data is a source of data obtained directly from the SDN 01 Perigi school. Data collection in this study was carried out using direct interview techniques with decision makers, namely the Principal of SD Negeri 01 Perigi, Tangerang, to obtain primary data, namely the original data needed for this research. From the results of the interviews, a list of names were given which would be alternative data candidates to be used in the study. Based on the results of interviews there were around 25 teachers at the school.

2.2 Population and Research Sample

Sugiyono[15] means that a population is taken from a place or area which can consist of an object that has certain characteristics determined by the researcher to be used in the research being carried out. The population and research sample are the total number of research objects that will be involved in a study. In this study, the object of research is the teacher. The total number of teachers at SD Negeri 01 Perigi, Tangerang is 25, with demographic details as follows:

Table I. Teacher Demographics

No	Gender	Total
1	Male	9
2	Female	16
Total		**25**

Based on Table 1, a total of 25 teachers were obtained, the number of teachers that will be used in this study as an alternative value.

2.3 Data Analysis Method

1. **T**he method used is the TOPSIS method or known as *Technique For Others Reference by Similarity to Ideal Solution*. Based on the data obtained, in research conducted at SD Negeri 01 Perigi, several research criteria were used to find outstanding teachers, namely:

Table II. Assessment

Criteria	Information
C1	Teacher Evaluation Value
C2	Absence
C3	Technology Proficiency
C4	Learning Innovation
C5	Pedagogic

Alternative solutions used in this study are a number of 25 teachers with the following description:

Table III. Table of Alternative Solutions

Alternative	Names
A1	NITA SUSANTI,S.Pd SD
A2	EEN WAHYUNI S.Pd SD
A3	TUTI SUPRIYATI, S.Pd SD
A4	WAHYUNI FITRY ABITA, S.Pd
A5	RIANA ARISTA
A6	SITI AISAH
A7	ROMENIH,S.Pd SD
A8	SYIFA
A9	UMI KULSUM,S.Pd
A10	NAWIYAH,S.Pd
A11	SURYANI JAYA,SE
A12	PANJI WAHYU UTOMO
A13	LILA SAKILLA,S.Pd SD
A14	NURBAITI,S.Pd SD
A15	HJ.SITI RUPIATUN, S.Pd

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A16	SANTI KOMALAWATI,S.Pd
A17	RISTA MILA KARMELIA, S.Pd
A18	DEDEH MAOLIDAH S.Pd SD
A19	NUR HASANAH,S.Pd
A20	ARBAINI,S.Ag
A21	ABDUL QODIR, M.Ag
A22	UUS HUSNA, S.Ag
A23	DEDEN SAPUTRA,S.Pd
A24	DEDE ROBIATUL
A25	LUTHFIAH

3. Hwang and Yoon developed a technique for solving *Multicriteria Decision Making* problems known as the TOPSIS method. To support the *Euclidean* distance, they propose PIS and NIS and each criterion needs to be maximized or minimized. They claim that the TOPSIS method helps sort the closeness of alternatives based on the optimal ideal solution and obtain the maximum level of available alternatives. The following are the steps and calculation formulas for calculating the TOPSIS method based on the decision support system book [16] namely:

A. Creating a matrix that has been normalized based on criteria and alternatives

In this first step, normalization is carried out on the matrix that has been built previously based on the criteria and alternative values. As for this stage, an assessment of the performance of each alternative is required against the criterion value.

$$rij = \frac{X_{ij}}{\sqrt{\sum_{i=1}^{m} X_{ij}^2}} \quad \text{.....(1)}$$

Where the value of r_{ij} is the matrix normalization value, the value of x_{ij} is the value of the weight of the jth criterion in the ith alternative, the i value is the ith alternative value, and the j value is the jth criterion value.

B. Create a weighted matrix normalization

$$Y = \begin{pmatrix} y_{11} & y_{12} & y_{1j} \\ y_{21} & y_{22} & y_{2j} \\ y_{i1} & y_{i2} & y_{ij} \end{pmatrix} \text{ for yij = wj.rij.....(2)}$$

Where the value of Wj is the weight value of the j-criteria, and the value of Yij is the value of the 3-normalized decision matrix

.

C. Determine positive ideal solutions and negative ideal solutions

$$A^+ = (y_1^+, y_2^+, ...y_i^+)$$
$$A^- = (y_1^-, y_2^-, ...y_i^-) \quad \text{.....(3)}$$

Where:

$y_j^+ =$ max yij, if j is *benefit* where is min yij, if j is attribute *cost*

$y_j^- =$ min yij, if j is *benefit* and max yij value, if j is attribute *cost*

D. Determine the distance between (D+) and (D-) to determine positive and negative solutions

$$D_i^+ = \sqrt{\sum_{i=1}^{n} (y_i^+ - y_{ij})^2} \text{ ; i=1,2, ...m.....(4)}$$

$$D_i^- = \sqrt{\sum_{i=1}^{n} (y_{ij} - y_i^-)^2} \text{ ; i=1,2, ...m.....(5)}$$

E. The last step is to determine the preference value for each alternative

$$Vi = \frac{D_i^-}{D_i^- + D_i^+} \text{ ; i=1,2,..m.....(6)}$$

Where a larger Vi value indicates alternative priority

III. RESULTS AND DISCUSSION

The results of the research which describe the calculation stages of the TOPSIS method based on data obtained at the research location, namely SD Negeri 01 Perigi, which was given by the Principal.

3.1 TOPSIS Calculation Results

In this study, based on some of the previous research literature, and based on the results of discussions with the Principal of SDN 01 Perigi Tangerang, it was decided to use 5 criteria and weights, namely as shown in table IV

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Table IV .Criteria and Weight Assessment

Criteria	Description	Cost/Benefit	Weight
C1	Teacher Evaluation Score	Benefit	4
C2	Absence	Benefit	5
C3	Technology Proficiency	Benefit	4
C4	Learning Innovation	Benefit	3
C5	Pedagogic	Benefit	3

A. Assessment based on alternatives and criteria

At this stage calculations are carried out using the TOPSIS method , the first step in starting the calculation is to evaluate each alternative data that is owned with each of the existing criteria, which can be seen in the table below

Table V Assessment Based On Criteria and Alternative

Alternatif / Kriteria	(C1)	(C2)	(C3)	(C4)	(C5)
A1	89	98	80	87	82
A2	87	98	85	87	80
A3	87	96	87	87	82
A4	86	98	95	94	82
A5	82	87	90	90	80
A6	82	85	87	86	80
A7	84	90	80	80	80
A8	89	85	95	92	82
A9	84	95	78	80	80
A10	82	85	78	80	80
A11	80	90	75	78	78
A12	84	95	95	85	78
A13	84	85	90	85	78
A14	82	70	80	78	78
A15	82	90	78	80	80
A16	80	85	78	78	78
A17	86	90	95	92	84
A18	80	87	80	80	75
A19	80	90	85	87	80
A20	86	95	90	90	84
A21	84	95	90	89	80
A22	83	89	87	85	80
A23	79	70	80	78	75
A24	78	85	80	78	75
A25	82	85	95	85	78

B.Normalized Calculation Matrix

Table VI .Normalized Matrix

Matrix Normalization					
Alternatives	C1	C2	C3	C4	C5
A1	0,21360	0,22020	0,18698	0,20570	0,20604
A2	0,20880	0,22020	0,19867	0,20570	0,20101
A3	0,20880	0,21571	0,20334	0,20570	0,20604
A4	0,20640	0,22020	0,22204	0,22225	0,20604
A5	0,19680	0,19548	0,21036	0,21279	0,20101
A6	0,19680	0,19099	0,20334	0,20333	0,20101
A7	0,20160	0,20222	0,18698	0,18915	0,20101
A8	0,21360	0,19099	0,22204	0,21752	0,20604
A9	0,20160	0,21346	0,18231	0,18915	0,20101
A10	0,19680	0,19099	0,18231	0,18915	0,20101
A11	0,19200	0,20222	0,17530	0,18442	0,19599
A12	0,20160	0,21346	0,22204	0,20097	0,19599
A13	0,20160	0,19099	0,21036	0,20097	0,19599
A14	0,19680	0,15728	0,18698	0,18442	0,19599
A15	0,19680	0,20222	0,18231	0,18915	0,20101
A16	0,19200	0,19099	0,18231	0,18442	0,19599
A17	0,20640	0,20222	0,22204	0,21752	0,21106
A18	0,19200	0,19548	0,18698	0,18915	0,18845
A19	0,19200	0,20222	0,19867	0,20570	0,20101
A20	0,20640	0,21346	0,21036	0,21279	0,21106
A21	0,20160	0,21346	0,21036	0,21043	0,20101
A22	0,19920	0,19998	0,20334	0,20097	0,20101
A23	0,18960	0,15728	0,18698	0,18442	0,18845
A24	0,18720	0,19099	0,18698	0,18442	0,18845
A25	0,19680	0,19099	0,22204	0,20097	0,19599

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C. Weighted Normalization Matrix

The next step is to calculate the Weighted Normalization Matrix where each alternative value is taken from the criterion weight value multiplied by the normalization result, the following is the formula for weighted normalization calculations

Table VII .Weighted Normalization

Alternative	Weighted Normalization				
	C1	C2	C3	C4	C5
A1	0,85441	1,10102	0,74795	0,61711	0,61812
A2	0,83521	1,10102	0,79469	0,61711	0,60304
A3	0,83521	1,07855	0,81339	0,61711	0,61812
A4	0,82561	1,10102	0,88819	0,66676	0,61812
A5	0,78721	0,97743	0,84144	0,63839	0,60304
A6	0,78721	0,95496	0,81339	0,61001	0,60304
A7	0,80641	1,01114	0,74795	0,56745	0,60304
A8	0,85441	0,95496	0,88819	0,65257	0,61812
A9	0,80641	1,06731	0,72925	0,56745	0,60304
A10	0,78721	0,95496	0,72925	0,56745	0,60304
A11	0,76801	1,01114	0,70120	0,55327	0,58797
A12	0,80641	1,06731	0,88819	0,60292	0,58797
A13	0,80641	0,95496	0,84144	0,60292	0,58797
A14	0,78721	0,78644	0,74795	0,55327	0,58797
A15	0,78721	1,01114	0,72925	0,56745	0,60304
A16	0,76801	0,95496	0,72925	0,55327	0,58797
A17	0,82561	1,01114	0,88819	0,65257	0,63319
A18	0,76801	0,97743	0,74795	0,56745	0,56535
A19	0,76801	1,01114	0,79469	0,61711	0,60304
A20	0,82561	1,06731	0,84144	0,63839	0,63319
A21	0,80641	1,06731	0,84144	0,63129	0,60304
A22	0,79681	0,99990	0,81339	0,60292	0,60304
A23	0,75841	0,78644	0,74795	0,55327	0,56535
A24	0,74881	0,95496	0,74795	0,55327	0,56535
A25	0,78721	0,95496	0,88819	0,60292	0,58797

D. Positive and Negative Ideal Solutions

Table VIII .Positive and Negative Ideal Seolution

	C1	C2	C3	C4	C5
A+	0,85441	1,1010	0,88812	0,6667	0,63319
A-	0,74881	0,7864	0,70126	0,5532	0,56535

E. Calculation Results of Ideal Solution Distance D+ and D-

Table IX .Ideal Solution Distance

Alternatives	D+	D-
A1	0,149533	0,345189
A2	0,111733	0,347363
A3	0,095711	0,335021
A4	0,032508	0,394318
A5	0,15391	0,257461
A6	0,188603	0,217031
A7	0,202041	0,24003
A8	0,147514	0,295232
A9	0,198677	0,290888
A10	0,248757	0,179676
A11	0,255801	0,226648
A12	0,097781	0,346625
A13	0,178724	0,233157
A14	0,371576	0,064586
A15	0,220515	0,233179
A16	0,262649	0,173398
A17	0,095441	0,325294
A18	0,238474	0,198075
A19	0,16631	0,255137
A20	0,070397	0,341033
A21	0,088274	0,330732
A22	0,155309	0,253661
A23	0,381216	0,047723
A24	0,263882	0,174887
A25	0,178798	0,260415

F. Calculating the Preference value

Table X Preference Value

Alternatif	V
A1	0,697743
A2	0,756624
A3	0,777795
A4	0,923838
A5	0,62586
A6	0,535041
A7	0,542967
A8	0,666821
A9	0,594176
A10	0,419379
A11	0,469787
A12	0,779973
A13	0,56608
A14	0,148077
A15	0,513957
A16	0,397659

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Alternatif	V
A17	0,773156
A18	0,453729
A19	0,605383
A20	0,828896
A21	0,789324
A22	0,620244
A23	0,111257
A24	0,398585
A25	0,592913

3.2 Verification of TOPSIS Calculations with the TOPSIS Application Tool

Verification activities are carried out to ensure that the calculations which has been done manually in this study was appropriate. The application used was developed on a local server environment, namely http://localhost and using PHP and Mysql. The following is a display of the TOPSIS stages using the TOPSIS calculation application using research data at SDN 01 Perigi Tangerang

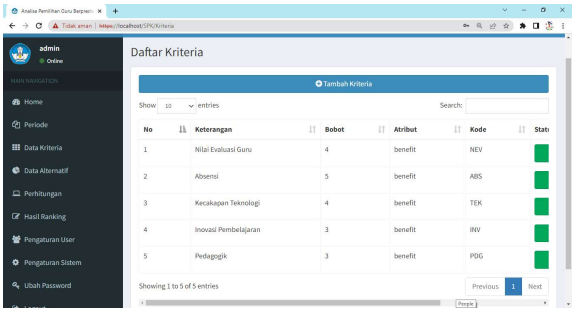

Fig1. Input Research Criteria and Criteria Weight

Figure 1 above is a display of the TOPSIS calculation application where the display menu is used to enter criteria where based on this research there are 5 Criteria, namely Evaluation Value (C1), Absence (C2), Technology Proficiency (C3), Learning Innovation (C4), and Pedagogic (C5). Then input is done sequentially on each criterion with a value (4, 5, 4, 3, 3).

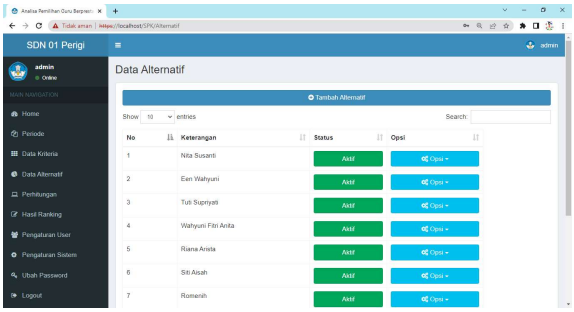

Fig 2 Alternative Data Input

Figure 2 above is a display of the TOPSIS calculation application where the menu display is used to enter alternatives along with assessments based on criteria where based on this study there are 25 alternatives.

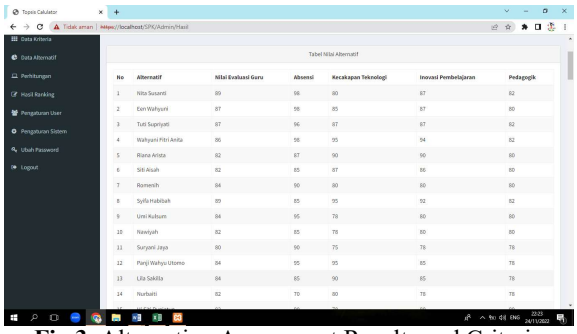

Fig 3. Alternative Assessment Results and Criteria

Figure 3 above is a display of the TOPSIS calculation application where the menu display is used to see the results of the calculation data for each alternative based on 5 criteria, meaning that each teacher is given an assessment by an assessor, namely the Principal.

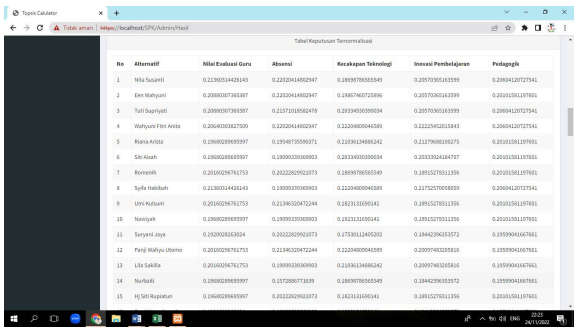

Fig 4. Normalization Matrix Assessment Results

Figure 4 above is a display of the TOPSIS calculation application where the menu display is used to calculate matrix normalization results from 25 alternatives.

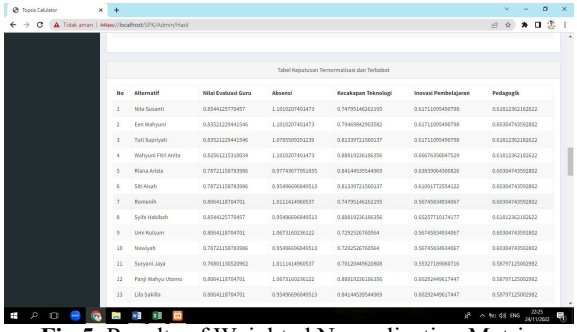

Fig 5. Results of Weighted Normalization Matrix Assessment

Figure 5 above is a display of the TOPSIS calculation application where this menu display is used to calculate weighted normalization results based on the continuation of the previous calculation.

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Fig 6. Positive Ideal Solutions A+ and Negative A-

Figure 6 above is a display of the TOPSIS calculation application where the menu display is used to see the calculation results of the Ideal Positive A+ and Negative A- solutions.

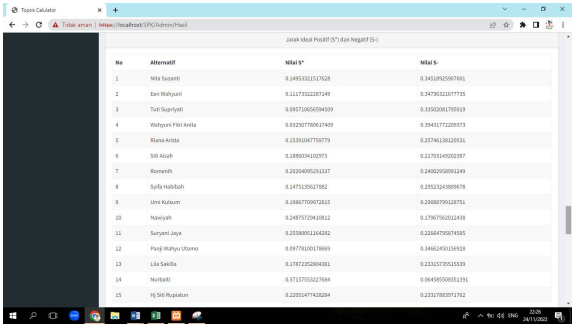

Fig 7. Display of Calculation Results of Positive and Negative Ideal Solution Distances

Figure 7 above is a display of the TOPSIS calculation application where the menu display is used to see the calculation results of the Calculation Results of Positive and Negative Ideal Solution Distances based on the values A+ and A- in the previous calculation .

No	Alternatif	Nilai RC
1	Wahyuni Fitri Anita	0.9238382406632
2	Arbaini	0.8288960859932
3	Abdul Qodir	0.7893242549345
4	Panji Wahyu Utomo	0.7799734678164
5	Tuti Supriyati	0.7777950712942
6	Rista Milla Karmella	0.7731564517488
7	Een Wahyuni	0.7566236345527
8	Nita Susanti	0.6977432339165
9	Syifa Habibah	0.6668212417653
10	Riana Arista	0.6258604610300
11	Uus Husna	0.6202435374826
12	Nur Hasanah	0.6053831188600
13	Umi Kulsum	0.5941763345177
14	Luthfiah	0.5929129131506
15	Lila Sakilla	0.5660795746197
16	Romenih	0.5429667138148
17	Siti Aisah	0.5350414640898
18	Hj Siti Rupiatun	0.5139566273846
19	Suryani Jaya	0.4697868739
20	Dedeh Maolidah	0.4537289706818
21	Nawiyah	0.4193786568575
22	Dede Robiatul	0.3955852955291
23	Santi Kemalawati	0.3976589864877
24	Nurbaiti	0.1480772062043
25	Deden Saputra	0.1112572857825

Fig 8 Preference Calculation Results

Based on Figure 8 above, it can be ascertained that the ranking order is the same as the manual results where out of 25 names the 10 highest names will be taken as outstanding teachers. The results of the ranking can be used by decision makers, namely the Principal in the form of an official circular generated by the application which can be seen in Figure 9 below,

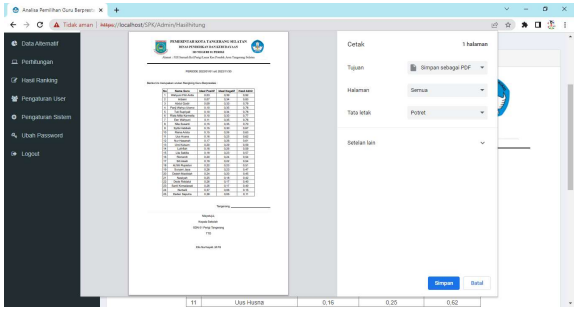

Fig 9. Results of the TOPSIS Rating Form

The comparison of the results of manual calculations and using the application can be seen in Table XI below,

Table XI .Results Comparison

Rank	Manual Calculation	Manual Score	Application Calculation	Application Score
1	Wahyuni Fitri Anita	0,923838	Wahyuni Fitri Anita	0,923838
2	Arbaini	0,828896	Arbaini	0,828896
3	Abdul Qodir	0,789324	Abdul Qodir	0,789324
4	Panji Wahyu Utomo	0,779973	Panji Wahyu Utomo	0,779973
5	Tuti Supriyati	0,777795	Tuti Supriyati	0,777795
6	Rista Milla Karmella	0,773156	Rista Milla Karmella	0,773156
7	Een Wahyuni	0,756624	Een Wahyuni	0,756624
8	Nita Susanti	0,697743	Nita Susanti	0,697743
9	Syifa Habibah	0,666821	Syifa Habibah	0,666821
10	Riana Arista	0,62586	Riana Arista	0,62586

Based on the ranking and validation results between manual calculations in Table IV.10, the results obtained are 10 teacher ratings achievement at SDN 01 Perigi Tangerang, with first to tenth place, namely Wahyuni Fitri Anita (0.923838), Arbaini (0.828896), Abdul Qodir (0.789324), Panji Wahyu Utomo (0.779973), Tuti Supriyati (0.777795) Rista Milla Karmella (0.773156), Een Wahyuni (0.756624), Nita Susanti (0.697743), Syifa Habibah (0.666821), Riana Arista (0.62586).

IV. CONCLUSION

Based on the results of the research that was carried out in this study using the TOPSIS method to determine outstanding teachers at SD Negeri 01 Perigi, the following conclusions were obtained:

1. The results of calculations using TOPSIS are able to provide a ranking order for the 10 best achieving teachers, namely Wahyuni Fitri Anita, Arbaini, Abdul Qodir, Panji Wahyu Utomo, Tuti Supriyati, Rista Milla Karmella, Een Wahyuni, Nita Susanti, Syifa Habibah, and Riana Arista.
2. Calculation results using TOPSIS can be used by SD Negeri 01 Perigi as a reference for Assessment Criteria in making decisions to determine Outstanding Teachers
3. Calculation results using TOPSIS can reduce the subjectivity of teacher assessments made by decision makers.

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Suggestions that can be given for further research are as follows:

1. Application program with the TOPSIS method can be developed that can be implemented at the research location
2. Additional criteria for other assessment criteria can be carried out in order to see differences in ranking results with the addition of additional criteria.
3. Comparative analysis can be carried out using different methods with the same research data to see if there are differences in the results and accuracy of the calculation results of other methods.

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DECISION SUPPORT SYSTEM FOR DETERMINING DEPARTMENT USING THE PROFILE MATCHING INTERPOLATION METHOD AT WIKRAMA VOCATIONAL SCHOOL, BOGOR

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Abstract – Wikrama Vocational High School is one of the schools that routinely carries out the determination of majors every year. The majors process at Wikrama is carried out in the tenth grade by the Guidance and Counseling Teacher (BK Teacher) and the Head of Expertise Competence (Kakomli). BK and Kakomli teachers have difficulty determining the results of majors when there are more interest in one major than other majors, there is a mismatch of majors results because they are not in accordance with the existing majors in the chosen field of expertise and the process of majors is not accurate and fast. This is because it has not used an objective mechanism for determining majors, there is no weighting process, and there is no information system available. Therefore, it is necessary to develop a decision support system (DSS) to assist the process of determining majors using Profile Matching and Interpolation methods. The Profile Matching method is used for appraising decisions, while the Interpolation method is used for the weighting process. The criteria used in each field of expertise are Informatics Engineering with 11 criteria and Computers, Business Management with 8 criteria, and Tourism with 7 criteria. Based on the results of testing and validation that have been carried out by experts, it has an accuracy value of 93%. The accuracy value indicates that the system can provide recommendations for determining the right major. In addition, the interpolation weighting method is proven to increase the accuracy value compared to the ordinal weighting value in Profile Matching. The results of this study are in the form of a decision support system that helps in determining majors objectively, quickly and accurately.

Keywords – ***Decision Support System, majors, profile matching, interpolation***

I. INTRODUCTION

Determination of majors in high school is usually determined by academic ability which is supported by interest factors so that students can study a science that suits their personality characteristics. The interest factor in SMK aims to provide opportunities for students to develop attitudes, knowledge competencies, and skill competencies according to their interests, talents and/or abilities in a major. Selection of specialization groups is based on report cards and/or recommendations from BK teachers and/or placement test results at SMK [1].

Majors at Wikrama Bogor Vocational School are carried out by Counseling Teachers and Heads of Expertise Competency (Kakomli) with criteria in the field of Informatics and Computer Engineering expertise, namely MTK Middle School Report Card Scores, Middle School Report Card English Grades, MTK Matriculation Scores, Matriculation English Grades, Matriculation KDK Scores, Matriculation Algorithm Values, Logic Values, Creativity Values, Color Blindness, Major Interests and Gender, then criteria in the field of Business Management expertise, namely MTK Middle School Report Card Scores, Middle School Report Card English Grades, MTK Matriculation Scores, Matriculation English Grades, Matriculation KDK Scores , Interview Scores, Major Interests, Gender and criteria in the area of expertise in Tourism are Middle School Report Card MTK Scores, Middle School Report Card English Grades, MTK Matriculation Scores, Matriculation English Grades, Matriculation PJOK Scores, Interview Scores, Major Interests. Where each student has chosen the desired area of expertise for further selection in determining the majors in that area of expertise so that when the results have been determined they must be in accordance with the existing majors in the chosen area of expertise.

During the majors process, Counseling Teachers and Kakomli experienced difficulties in determining the results of majors when there were more enthusiasts for one major than other majors. Some students ask to change majors with reasons of incompatibility because the results of the majors are not in accordance with the existing majors in the chosen area of expertise. Then the BK teacher and Kakomli still have difficulties in an accurate and fast assessment process. This is because there is no weighting process for each criterion and the determination of the final grade calculation still uses the average so that it cannot be known which criteria have a more important effect for a particular major.

There have been many implementations of decision support systems in various fields, including in terms of determining majors including [2],[3],[4],[5],[6],[7],[8]. There are also quite a lot of methods used to determine recommendations for decision support system solutions. These include the Multifactor Evaluation Process, Simple Additive Weighting, Analythical Hierarchy Process, Techique for Order Preference by Similarty to Ideal Solution, Vise Kriterijuska Optimizacija I Kompromisno Resenje, Fuzzy C-mean Algorithm, Profile Matching.

Perdana et al (2021) explained that in order to obtain calculations with faster and more objective results[9], of course, it is necessary to carry out a weighting process and make an appraiser's decision based on proximity to the criteria. This is in line with the case study in determining

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this major. The suitable method in determining majors based on compatibility between student profiles and majors is the profile matching method. Then to get more objective and precise results, it is necessary to use interpolation in the weighting process. [10] explained that the application of interpolation weighting succeeded in increasing the accuracy value compared to the ordinal weighting method.

Based on the background above, this research focuses on the interpolation profile matching method in determining the direction that suits the needs of SMK Wikrama Bogor.

II. RESEARCH METHODOLOGY

A. Research methods

The research to be carried out is a type of quantitative research, which is to take a sample of student data along with existing indicators, then the data is processed using the Profile Matching Interpolation method, the end result is to recommend student majors.

B. Population and Sample Selection Methods

At this stage the researcher chose the population and sample, where the population was students of class x (ten) at Wikrama Bogor Vocational School and the sample was majoring data for the 2020-2021 school year with a total of 642 students.

C. Method of collecting data

Data collection uses research instruments, analysis and is quantitative or statistical with the aim of testing the hypotheses that have been applied.

Data collection methods that will be used in this study are:

1. Interview

The resource persons in this study were Counseling Guidance Teachers/Counseling Teachers at SMK Wikrama Bogor, namely Ms. Novya Azhari to gather information about the process of majoring and what are the criteria for making decisions in recommending majors.

2. Internal Data

The internal data used for this research is class x (ten) student data. The description of the data on the realization of majors at SMK Wikrama Bogor can be seen in Table 1.

D. Analysis Techniques

The analysis technique used in this study uses a Decision Support System (DSS) approach. The process of analysis was carried out on the results of the stages of data collection by interviews, observation and literature study. In the analysis process, the techniques used are:

1. Analysis of data from a running system. This is done on documents, procedures, databases, and results of reports from the running system.
2. Analysis of the needs of system users, modeling of these needs and what functions are obtained by system users.

E. Research Steps

In order for this research to be carried out properly, a structured research method is needed. The research steps carried out are presented in Figure 1.

The steps contained in Figure 3.1 include:

1. Data Setup

This stage is the initial data processing to obtain the parameters used in determining the suitability of majors with student profiles. The data is in the form of student data, value data, majors data. The preparation of this data is done by interviewing and verifying the counseling teachers.

2. Determination of Majors

At this stage, consultations were carried out with the guidance counselor to determine the majors at SMK Wikrama Bogor. It is known that at SMK Wikrama Bogor there are 7 majors which are divided into 3 areas of expertise, namely: Informatics and Computer Engineering (Software Engineering, Multimedia and Computer and Network Engineering), Business Management (Office Automation and Governance) and Tourism (Hospitality and Catering).

3. Determination of Criteria

At this stage it was carried out based on student data in consultation with the BK teacher and the Head of the Department, several parameters were obtained that influenced the determination of majors. The outputs from this stage are 11 (eleven) criteria for majors in the field of ICT expertise, 8 (eight) criteria for majors in the field of Business Management and 7 (seven) criteria for majors in the field of Tourism.

4. scoring

This stage is the determination of suitability matching between student profiles and majors. The method used to perform suitability matching is the Profile Matching method which produces a prototype of the DSS model for determining majors.

5. Model Testing

The final stage of this research is testing the resulting model (prototype). A series of tests were carried out to determine the quality of the resulting model by looking at the accuracy value. Verification of the outcome of the model (prototype) was carried out by the Counseling Teacher and Head of Department who have handled the process of determining majors at SMK Wikrama Bogor for more than 2 (two) years.

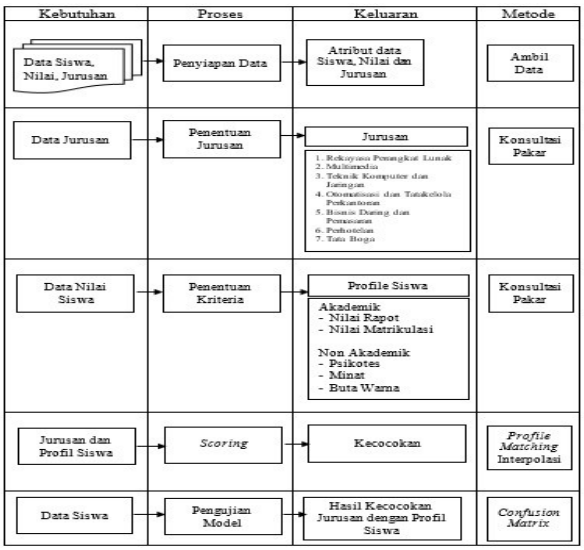

Fig 1. Research Steps

E. 1. Data Setup

At the data preparation stage, data collection was carried out. The purpose of this stage is to obtain the parameters used for the development of the SPK model for

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determining majors. The preparation of this data is done by interviewing and verifying the counseling teachers.

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Table 1. Data Preparation

Name	Middle school report cards MTK grades	Middle School Report Card English Grades	MTK Matriculation Value	Matriculation English Grades	Matriculation KDK score
1	2	3	4	5	6
Aditiya Putra Kurniawan (12007627)	87	89	91	83	83
Aditya (12007628)	79	81	86	75	93
Agung Setiawan (12007635)	73	77	95	75	95
Febiani Aulia Saputra (12007801)	87	89	87	78	90
Muhammad Alfharizzi (12007971)	79	80	81	75	75
Nadila Zari Fani (12008035)	81	78	83	80	88
Pingkan Yuki Fitria (12008083)	79	82	90	80	83
Rio Ferdinand (12008132)	81	85	87	83	88
…	…	…	…	…	…
Zalfa Maula Bagya (12008247)	78	87	90	95	85

Table 2. Criteria Weighting

Matriculation Algorithm Value	Logic Value	Creativity Value	Color blind	Department Interests	Gender
7	8	9	10	11	12
75	76	70	TBW	RPL	L
83	70	70	TBW	mmd	L
78	70	70	TBW	TKJ	L
83	85	70	TBW	RPL	P
75	70	70	TBW	TKJ	L
83	76	70	TBW	RPL	P
75	70	78	TBW	mmd	P
83	76	70	TBW	RPL	L
…	…	…	…	…	…
83	70	76	TBW	mmd	P

E.2. Determination of Majors

At this stage it was carried out based on student data in consultation with the BK teacher and the Head of the Department, several parameters were obtained that influenced the determination of majors. The outputs from this stage are 11 (eleven) criteria for majors in the field of ICT expertise, 8 (eight) criteria for majors in the field of Business Management and 7 (seven) criteria for majors in the field of Tourism. The rules that exist at SMK Wikrama Bogor include:

1. The Department of Computer and Network Engineering only accepts men and the Department of Automation and Office Management only accepts women, other than that it can be either a man or a woman.
2. The Department of Computer and Network Engineering does not accept students who are color blind
3. Provisions for majors cannot cross fields of expertise, namely when students are interested in the ICT field, the majors that must be matched are the majors in that area of expertise.

E.3. Determination of Criteria

Determination of major criteria was obtained from the results of consultations with experts at SMK Wikrama Bogor involving Counseling Guidance Teachers (BK Teachers) and Heads of Expertise Competence (Kakomli). The results of consultations with experts obtained data from 642 students who would be tested. In addition, based on consultations with experts, 11 (eleven) criteria were obtained for the area of expertise in Informatics and Computer Engineering, 8 (eight) criteria for the area of expertise in Business Management, and 7 (seven) criteria for the area of expertise in Tourism.

The criteria that will be used in this study in determining the majors are as follows:

a. Criteria in the Field of ICT Expertise
   1) Middle school report card MTK grades (K1)

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2) MTK English Grades Middle School Report Card (K2)
3) MTK Matriculation Value (K3)
4) Matriculation English Score (K4)
5) KDK Matriculation Value (K5)
6) Matriculation Algorithm Value (K6)
7) Logic Value (K7)
8) Creativity Value (K8)
9) Color Blind Value (K9)
10) Major Interest Score (K10)
11) Gender Value (K11)

b. Criteria in the Field of Management Business Expertise
1) Middle school report card MTK grades (K1)
2) MTK English Grades Middle School Report Card (K2)
3) MTK Matriculation Value (K3)
4) Matriculation English Score (K4)
5) KDK Matriculation Value (K5)
6) Interview Value (K6)
7) Major Interest Score (K7)
8) Gender Value (K8)

c. Criteria in the Field of Tourism Expertise
1) Middle school report card MTK grades (K1)
2) MTK English Grades Middle School Report Card (K2)
3) MTK Matriculation Value (K3)
4) Matriculation English Score (K4)
5) Matriculation PJOK Score (K5)
6) Interview Value (K6)
7) Major Interest Score (K7)

The following is an explanation of each of the criteria used in this study, namely:

a. ICT Expertise
1) Mathematics and English grades from junior high school report cards
Mathematics and English grades originating from junior high school report cards or equivalent are criteria that influence the determination of majors. The calculation of math scores and English scores is determined by the educational unit with the value interval i shown in Table 3.

Table 3 Criteria Interval Scores in Mathematics and English Middle School Report Cards

intervals	Weight
88-100	5
76-87	4
71-75	3
64-70	2
60-63	1
<60	0

2) Mathematics and English Scores from Matriculation Results
Mathematics and English grades derived from the matriculation results are the criteria that influence the determination of majors, where the matriculation results are obtained at the beginning of the learning period for class x (ten). The calculation of math scores and English scores is determined by the educational unit with the value intervals shown in Table 4.

Table 4. Mathematical and English score intervals for matriculation results

Intervals	Weight
95-100	5
85-94	4
80-84	3
70-79	2
60-69	1
<60	0

3) Value of Basic Computer Skills (KDK) and Algorithms
The KDK and Algorithm values derived from the results of matriculation are criteria that influence the determination of majors, where the results of this matriculation are obtained at the beginning of the learning period for class x (ten) with interval values equivalent to the scores of productive subjects in Vocational High Schools. The calculation of the KDK and Algorithm values is determined by the educational unit with the value intervals shown in Table 5.

Table 5. KDK Value Interval and Algorithm

intervals	Weight
95-100	5
85-94	4
80-84	3
70-79	2
60-69	1
<60	0

4) The Value of Logic and Creativity
The value of logic and creativity that comes from the results of the psychological test is a criterion that influences the determination of majors with interval values equivalent to the scores of productive subjects in SMK. The calculation of logical value and creativity value is determined by the educational unit with the value interval i shown in Table 6.

Table 6. Logic and Creativity Value Intervals

intervals	Weight
95-100	5
85-94	4
80-84	3
70-79	2
60-69	1
<60	0

5) Color Blind Value
The value of color blindness is one of the criteria that influences the determination of majors,

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especially for the Computer and Network Engineering and Multimedia Engineering major. For the two majors, there should not be students who are color blind, this is because it will affect the vocational learning process.

6) Major Interest Value
Majors Interest Value is one of the criteria that influences the determination of majors. The value of interest in this major will of course be related to the values of other criteria such as the value of logic, the value of creativity and color blindness.

7) Gender Value
The value of gender is one of the criteria that influences the determination of majors, where there are specializations such as the example for the Computer and Network Engineering major only for Men, while the Multimedia and Software Engineering major can be for Men and Women.

b. Field of Management Business Expertise

1) Mathematics and English grades from junior high school report cards
Mathematics and English grades originating from junior high school report cards or equivalent are criteria that influence the determination of majors. The calculation of math scores and English scores is determined by the educational unit with the value intervals shown in Table 7.

Table 6. Interval Criteria for Mathematics and English Middle School Report Cards

intervals	Weight
88-100	5
76-87	4
71-75	3
64-70	2
60-63	1
<60	0

2) Mathematics and English Scores from Matriculation Results
Mathematics and English grades derived from the matriculation results are the criteria that influence the determination of majors, where the matriculation results are obtained at the beginning of the learning period for class x (ten). The calculation of math scores and English scores is determined by the educational unit with the value interval i shown in Table 8.

Table 8. Mathematical and English score intervals for matriculation results

intervals	Weight
95-100	5
85-94	4
80-84	3
70-79	2
60-69	1
<60	0

3) Basic Computer Skills Value (KDK)
The KDK score derived from the results of matriculation is one of the criteria that influences the determination of majors, where the results of this matriculation are obtained at the beginning of the learning period for class x (ten) with interval values equivalent to the scores of productive subjects in Vocational High Schools. The calculation of the KDK value is determined by the educational unit with the value intervals shown in Table 9.

Table 9. KDK Value Interval and Algorithm

intervals	Weight
95-100	5
85-94	4
80-84	3
70-79	2
60-69	1
<60	0

4) Interview Value
The score of the interview is one of the criteria that influences the determination of majors with an interval value equal to the value of productive subjects at SMK. The calculation of the interview value is determined by the education unit with the value intervals shown in Table 10.

Table 10. Interval of Interview Values

intervals	Weight
95-100	5
85-94	4
80-84	3
70-79	2
60-69	1
<60	0

5) Major Interest Value
Majors interest value is one of the criteria that influence the determination of majors. The value of this department's interest will of course be related to the values of other criteria such as interview scores.

6) Gender Value
The value of gender is one of the criteria that influences the determination of majors, where there are specializations such as the example for the Automation and Office Management majors only for Women, while the Online Business and Marketing majors can be for Men and Women.

c. Tourism Expertise

1) Mathematics and English grades from junior high school report cards
Mathematics and English grades originating from junior high school report cards or equivalent are criteria that influence the determination of majors. The calculation of math scores and English scores

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is determined by the educational unit with the value intervals shown in Table 11.

Table 11. Interval Criteria for Mathematics and English Middle School Report Cards

intervals	Weight
88-100	5
76-87	4
71-75	3
64-70	2
60-63	1
<60	0

2) Mathematics and English Scores from Matriculation Results
Mathematics and English grades derived from the matriculation results are the criteria that influence the determination of majors, where the matriculation results are obtained at the beginning of the learning period for class x (ten). The calculation of math scores and English scores is determined by the educational unit with the value intervals shown in Table 12.

Table 12. Mathematical and English score intervals for matriculation results

intervals	Weight
95-100	5
85-94	4
80-84	3
70-79	2
60-69	1
<60	0

3) Value of Physical Education, Sports and Health (PJOK)
The PJOK score derived from the matriculation results is one of the criteria that influences the determination of majors, where the matriculation results are obtained at the beginning of the learning period for class x (ten) with interval values equivalent to the scores of productive subjects in SMK. The calculation of the PJOK value is determined by the educational unit with the value intervals shown in Table 13.

Table 13. PJOK Value Intervals

intervals	Weight
95-100	5
85-94	4
80-84	3
70-79	2
60-69	1
<60	0

4) Interview Value
The score of the interview is one of the criteria that influences the determination of majors with an interval value equal to the value of productive subjects at SMK. The calculation of the interview value is determined by the educational unit with the value intervals shown in Table 14.

Table 14. Interval of Interview Values

intervals	Predicate
95-100	5
85-94	4
80-84	3
70-79	2
60-69	1
<60	0

5) Major Interest Value
Majors interest value is one of the criteria that influence the determination of majors. The value of this department's interest will of course be related to the values of other criteria such as interview scores.

E.4. *Scoring* Stage

At this stage a matching process is carried out between student profiles and majors which is divided into the following stages:

1. Identify the needs of the decision maker
2. Determination of the membership function of each criterion

III. RESULTS AND DISCUSSION

A. Accuracy Testing

The test results for calculating the accuracy value show that the SPK model is quite good. The test was carried out involving the BK teacher and the head of the department using 30 test data. The author tries to compare the results of accuracy testing between calculations determined by experts and decision support system applications as follows:

Table 15. Determination of Majors from Experts

Name	MTK Report Card Middle [illegible]	Middle School Report Card [illegible]	MTK Matriculation	Matriculation English	KDK	Algorithm	Logic	Creativity	Color blind	Department Interests	Gender	Major
Student 1	96	89	92	90	95	90	85	70	Not Color Blind	Software engineering	Woman	Software engineering
Student 2	94	93	94	90	90	90	70	83	Not Color Blind	Multimedia	Woman	Multimedia
Student 3	81	87	89	80	90	83	70	83	Not Color Blind	Multimedia	Woman	Multimedia
Student 4	76	78	75	75	85	83	75	70	Color blind	Multimedia	Man	Software engineering
Student 5	87	83	93	85	78	83	70	82	Not Color Blind	Multimedia	Woman	Multimedia

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Name	MTK Report Card Middle	Middle School Report Card	MTK Matriculation	Matriculation English	KDK	Algorithm	Logic	Creativity	Color blind	Department Interests	Gender	Major
Student 6	82	89	83	93	91	83	76	70	Not Color Blind	Software engineering	Woman	Software engineering
Student 7	71	68	75	75	75	75	70	70	Not Color Blind	Multimedia	Man	Multimedia
Student 8	92	89	90	82	95	90	78	70	Not Color Blind	Software engineering	Man	Software engineering
Student 9	87	89	87	78	90	83	85	70	Not Color Blind	Software engineering	Woman	Software engineering
Student 10	90	89	92	85	78	83	78	70	Not Color Blind	Software engineering	Woman	Software engineering
Student 11	71	73	75	75	75	75	78	70	Not Color Blind	Software engineering	Man	Software engineering
Student 12	63	71	81	75	78	83	76	70	Not Color Blind	Software engineering	Man	Software engineering
Student 13	76	77	75	75	75	75	70	70	Not Color Blind	Computer and Network Engineering	Man	Computer and Network Engineering
Student 14	83	83	90	88	93	83	76	70	Not Color Blind	Software engineering	Woman	Software engineering
Student 15	74	78	78	75	75	75	72	70	Not Color Blind	Computer and Network Engineering	Man	Computer and Network Engineering
Student 16	73	73	75	75	85	75	70	70	Not Color Blind	Computer and Network Engineering	Man	Computer and Network Engineering
Student 17	79	80	81	75	75	75	70	70	Not Color Blind	Computer and Network Engineering	Man	Computer and Network Engineering
Student 18	65	66	77	75	75	75	70	80	Not Color Blind	Multimedia	Man	Multimedia
Student 19	64	68	89	78	75	75	76	70	Not Color Blind	Software engineering	Man	Software engineering
Student 20	84	85	90	85	88	83	70	90	Color Blind	Multimedia	man_	Multimedia
Student 21	86	86	81	83	90	83	85	70	Not Color Blind	Software engineering	Woman	Software engineering
Student 22	80	87	90	80	93	83	70	80	Not Color Blind	Multimedia	Woman	Multimedia
Student 23	78	85	94	80	88	83	85	70	Not Color Blind	Software engineering	Woman	Software engineering
Student 24	90	87	90	88	90	83	70	85	Not Color Blind	Multimedia	Woman	Multimedia
Student 25	80	85	90	80	90	83	70	80	Not Color Blind	Multimedia	Woman	Multimedia
Student 26	76	79	93	90	95	90	76	70	Not Color Blind	Software engineering	Woman	Software engineering
Student 27	83	82	90	90	95	90	76	70	Not Color Blind	Software engineering	Woman	Software engineering
Student 28	83	83	90	80	93	83	70	80	Not Color Blind	Multimedia	Woman	Multimedia
Student 29	92	89	90	88	85	83	70	80	Not Color Blind	Multimedia	Woman	Multimedia
Student 30	78	87	90	95	85	83	70	76	Not Color Blind	Multimedia	Woman	Multimedia

For manual accuracy testing, it can be seen in Table 16. Experts are asked to determine the direction according to the criteria that have been presented which will then be compared with the results of the decision support system, which can be seen in Table 16.

Table 16. Accuracy Test Results with Interpolation Weighting

No	Name	Major (from Expert)	Major (from System)
1	Student 1	Software engineering	Rank 1 Software Engineering
2	Student 2	Multimedia	Multimedia Rank 1
3	Student 3	Multimedia	Multimedia Rank 5
4	Student 4	Software engineering	Multimedia Rank 117 (TKJ)
5	Student 5	Multimedia	Multimedia Rank 9
6	Student 6	Software engineering	Software Engineering Rank 6
7	Student 7	Multimedia	Multimedia Rank 119 (TKJ)
8	Student 8	Software engineering	Rank 3 Software Engineering
9	Student 9	Software engineering	Software Engineering Rank 4
10	Student 10	Software engineering	Software Engineering Rank 10
11	Student 11	Software engineering	Rank 199 Software Engineering (TKJ)
12	Student 12	Software engineering	Rank 198 Software Engineering (TKJ)
13	Student 13	Computer and Network Engineering	Computer and Network Engineering Rank 66
14	Student 14	Software engineering	Rank 8 Software Engineering
15	Student 15	Computer and Network Engineering	Computer and Network Engineering Rank 64
16	Student 16	Computer and Network Engineering	Computer and Network Engineering Rank 65
17	Student 17	Computer and Network Engineering	Computer and Network Engineering Rank 61
18	Student 18	Multimedia	Multimedia Rank 118 (TKJ)

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No	Name	Major (from Expert)	Major (from System)
19	Student 19	Software engineering	Rank 200 Software Engineering (TKJ)
20	Student 20	Multimedia	Multimedia Rank 4
21	Student 21	Software engineering	Rank 7 Software Engineering
22	Student 22	Multimedia	Multimedia Rank 6
23	Student 23	Software engineering	Rank 9 Software Engineering
24	Student 24	Multimedia	Multimedia Rank 2
25	Student 25	Multimedia	Multimedia Rank 10
26	Student 26	Software engineering	Software Engineering Rank 5
27	Student 27	Software engineering	Rank 2 Software Engineering
28	Student 28	Multimedia	Multimedia Rank 7
29	Student 29	Multimedia	Multimedia Rank 3
30	Student 30	Multimedia	Multimedia Rank 8

Based on the results of the comparison of accuracy testing in Table 16 above, it can be concluded that the manual system and the application are not much different, it's just that the application displays the calculation results in more detail down to the ranking, where the ranking will determine whether students enter the department according to the quota exist or not. With this it can be seen that the application of this decision support system has the same validity as the results of manual system determination by experts.

Table 16. displays the test results in the form of a *confusion matrix* , it can be seen that from all the test data (30 students) there were 11 people recommended to the Software Engineering major, 11 people were recommended to the Multimedia department and 8 people were recommended to the Computer and Network Engineering department.

Table 17 . Accuracy Testing *Confusion Matrix with Interpolation Weighting*

Accuracy Testing		*predicted*		
		Software engineering	Multimedia	Computer and Network Engineering
actual	Software engineering	10	1	0
	Multimedia	0	10	1
	Computer and Network Engineering	0	0	8

Table 17. Then the accuracy value can be calculated as follows:

$$Accuracy\ (\%) = \frac{(10+10+8)}{(10+1+0+0+10+1+0+0+8)} x\ 100\% = 93\%$$

From these calculations obtained an accuracy value of 93%. The accuracy value indicates that the system can provide recommendations for determining the direction correctly.

B. Comparison of Interpolation and Ordinal Weights

In making a comparison of the weighting method between interpolation weighting and ordinal weighting, the researcher performed an accuracy calculation using the ordinal weighting method with the same test data as in Table 15 and the results can be seen in Table 18.

Table 18. Accuracy Testing *Confusion Matrix* with Ordinal Weighting

Accuracy Testing		*predicted*		
		Software engineering	Multimedia	Computer and Network Engineering
actual	Software engineering	9	1	1
	Multimedia	1	7	3
	Computer and Network Engineering	2	0	6

Table 19. Then the accuracy value can be calculated as follows:

$$Accuracy\ (\%) = \frac{(9+7+6)}{(9+1+1+1+7+3+2+0+6)} x\ 100\% = 73\%$$

From these calculations obtained an accuracy value of 73%. The accuracy value indicates that the ordinal weighting is below the accuracy value calculated using interpolation weighting. To see the performance of the interpolation method, a comparison is made with the ordinal method which is the weighting of the *profile matching method* . Figure 1. presents the results of a comparison of the accuracy values of the interpolation weighting method with ordinal weighting.

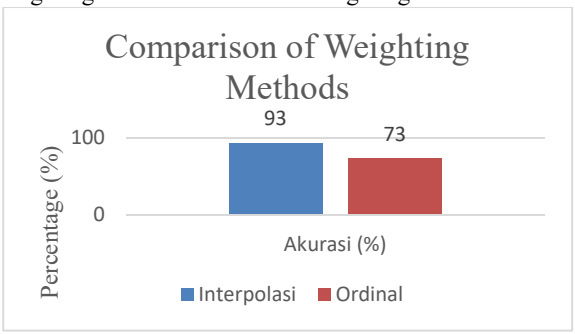

Fig 2. Comparison of Accuracy of *Profile Matching Method* with Interpolation Weighting and Ordinal Weighting

Figure 2. shows that the accuracy value of the *profile matching method* is higher when the interpolation weighting method is applied, compared to the ordinal weighting method. In interpolation weighting, the accuracy value increases compared to ordinal weighting. This can happen because in the interpolation weighting method, the resulting weight values are more accurate because they use a proportional weighting formula.

Meanwhile in ordinal weighting, the value of the weight is determined constant (fixed). Figure 3. presents an example of a comparison of weights on mathematical value parameters using the interpolated weighting method which will produce weights that are more flexible than ordinal weightings.

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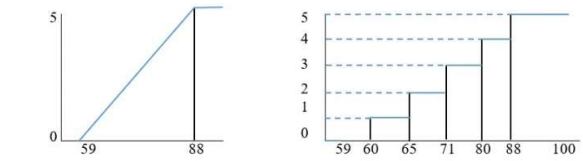

(a) Pembobotan nilai matematika Raport smp dengan metode interpolasi (b) Pembobotan nilai matematika Raport smp dengan metode ordinal

Fig 3. Comparison of determining the weighting of the criteria for the mathematics value of junior high school report cards using ordinal weighting and interpolation methods

C. User Acceptance Test (UAT)

At the testing stage with UAT, the researcher used descriptive analysis. Researchers provide or distribute questionnaires to *users* based on perceived usefulness *constructs* , perceived ease *of use constructs, and perceived user* acceptance constructs . Questionnaire-based UAT testing used a Likert scale and was given to 8 respondents from Counseling Guidance Teachers and Head of Skills Competency at SMK Wikrama Bogor as system users. The Likert scale is given a weighted value as below:

Table 18. Scale Weight

Code	Information	Weight
SS	Strongly agree	5
S	Agree	4
N	Neutral	3
TS	Don't agree	2
STS	Strongly Disagree	1

After the Likert scale is weighted, a question construct is created that will be used for the testing phase. The list of statements or questions from the questionnaire results is attached in the attachment.

1. The results of the UAT questionnaire weight in the aspect of perceived usefulness

Table 19. UAT Questionnaire Perceived Usefulness Construct

Name	Question					
	1	2	3	4	5	6
answer 1	5	5	4	4	5	5
answer 2	5	4	4	4	4	5
answer 3	4	4	4	3	4	5
answer 4	5	4	4	4	4	5
Answer 5	4	4	4	3	4	5
Respondent 6	4	4	4	3	4	5
Respondent 7	5	4	4	4	4	5
Respondent 8	4	4	4	3	4	5

2. The results of the UAT questionnaire weight in the aspect of perceived ease

Table 20. UAT questionnaire in the aspect of perceived ease

Name	Question				
	1	2	3	4	5
answer 1	5	5	4	4	5
answer 2	5	5	3	4	4
answer 3	4	5	3	3	4
answer 4	5	5	3	4	4
Answer 5	4	5	3	3	4
answer 6	4	5	3	3	4
Respondent 7	5	5	3	4	4
Respondent 8	4	5	3	3	4

3. The results of the UAT questionnaire weight in the aspect of user acceptance perception

Table 21. UAT questionnaire in the aspect of user acceptance perception

Name	Question			
	1	2	3	4
Respondent 1	5	3	5	4
Respondent 2	5	3	5	3
answer 3	5	3	5	4
answer 4	5	3	5	3
Answer 5	5	3	5	4
answer 6	5	3	5	4
Answer 7	5	3	5	3
answer 8	5	3	5	4

1. Testing Score Percentage (UAT)

For the percentage of scores the test was carried out with 8 respondents with a questionnaire referring to the UAT model. UAT testing uses a Likert scale. Likert scale values are interpreted using the intervals shown below:

Table 22. Score intervals

Score Intervals	Information
0%-19.99%	Strongly Disagree
20%-39.99%	Don't agree
40%-59.99%	Neutral
60%-79.99%	Agree
80%-100%	Strongly agree

To calculate the results of the UAT questionnaire, the following equation is used:

1. The total answer indicators are obtained by adding up each line of answer indicators
2. The actual score is obtained by multiplying the value weight by the number of answers
3. The actual total score is obtained by adding up each actual score value
4. The ideal score is obtained by multiplying the number of respondents with the highest weight
5. The ideal total score is obtained by multiplying the ideal score by the number of questions that exist.

The following is the calculation of the percentage of each determined perception aspect:

1. Percentage of Scores on Perceived *Usefulness Aspects*

Table 23. Percentage of Scores on Perceived Usefulness Aspects

Code	Weight	Questions						Total
		1	2	3	4	5	6	
SS	5	4	1	0	0	1	8	14
S	4	4	7	8	4	7	0	30
N	3	0	0	0	4	0	0	4
TS	2	0	0	0	0	0	0	0
STS	1	0	0	0	0	0	0	0
Number of Respondents		8						
Actual Score		36	33	32	28	33	40	202
Ideal Score		40	40	40	40	40	40	240

Table 23. is the result of a questionnaire study with 6 (six) questions or statements for the usability aspect submitted to the respondents, with the actual percentage score results as follows:

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$$\%\ Skor\ Aktual = \frac{Total\ Skor\ Aktual\ Kegunaan}{Total\ Skor\ Ideal} x100$$
$$\%\ Skor\ Aktual = \frac{202}{240} x100$$
$$\%\ Skor\ Aktual = 0{,}84x100$$
$$\%\ Skor\ Aktual = 84{,}17\%$$

With an actual % score of 84.17%, it can be concluded that the respondents strongly agree from the usability aspect.

2. Percentage of Scores on Perceived Ease of *Use*

Table 24. Percentage of Scores on Perceived Aspects of Ease of Use

Code	Weight	Questions					Total
		1	2	3	4	5	
SS	5	4	8	0	0	1	13
S	4	4	0	1	4	7	16
N	3	0	0	7	4	0	11
TS	2	0	0	0	0	0	0
STS	1	0	0	0	0	0	0
Jumlah Responden		8	8	8	8	8	8
Actual Score		36	40	25	28	33	168
Ideal Score		40	40	40	40	40	200

Table 24. is the result of a questionnaire research with 5 (five) questions or statements for aspects of ease of use submitted to respondents, with the actual percentage score results as follows:

$$\%\ Skor\ Aktual = \frac{Total\ Skor\ Aktual\ Kegunaan}{Total\ Skor\ Ideal} x100$$
$$\%\ Skor\ Aktual = \frac{168}{200} x100$$
$$\%\ Skor\ Aktual = 0{,}81x100$$
$$\%\ Skor\ Aktual = 81{,}00\%$$

With an actual % score of 81.00%, it can be concluded that the respondents strongly agree from the aspect of user convenience.

3. Percentage of Scores on the Aspect of User Acceptance (*Perceived User Acceptance*)

Table 25. Percentage of Scores on User Acceptance Aspects

Code	Weight	Questions				Total
		1	2	3	4	
SS	5	7	0	8	0	8
S	4	0	0	0	5	9
N	3	1	8	0	3	15
TS	2	0	0	0	0	0
STS	1	0	0	0	0	0
Number of Respondents		8				
Actual Score		38	24	40	29	131
Ideal Score		40	40	40	40	160

Table 25. is the result of a questionnaire study with 5 (five) questions or statements for aspects of user acceptance submitted to respondents, with the actual percentage score results as follows:

$$\%\ Skor\ Aktual = \frac{Total\ Skor\ Aktual\ Kegunaan}{Total\ Skor\ Ideal} x100$$
$$\%\ Skor\ Aktual = \frac{131}{160} x100$$
$$\%\ Skor\ Aktual = 0{,}82x100$$
$$\%\ Skor\ Aktual = 81{,}88\%$$

With an actual % score of 81.88%, it can be concluded that the respondents strongly agree from the aspect of user acceptance.

2. Conclusion of UAT Testing

Table 26. Test Conclusions

No	Indicator	Actual Score	Ideal Score	%Actual Score	Information
1	Perceived Usefulness	202	240	84.17 %	Strongly agree
2	Perception of Convenience	162	200	81.00 %	Strongly agree
3	Perceived User Acceptance	131	160	81.88 %	Strongly agree
Total		495	600	82.35 %	Strongly agree

Table 26. summarizes the results of UAT testing with 3 (three) aspects of testing, obtained from the percentage of model scores on the perceived usefulness aspect *of* 84.17%, the percentage of perceived ease of use aspects (perceived ease *of use*) of 81.00% and aspects of user acceptance (*User Acceptance*) of 81.88%. From the overall average test results using the UAT method of 82.35%, it is concluded that the *user* strongly agrees with the proposed system.

IV. CONCLUSION

Based on the research and discussion that has been done, it can be concluded as follows:

1. This research produces a decision support system model for determining majors using the Profile Matching Interpolation method that suits your needs.
2. Based on the results of testing the decision support system model for determining the direction, an accuracy value of 93% was obtained.
3. The decision support system model for determining the direction using the Profile Matching method with interpolation weighting has succeeded in increasing the accuracy value compared to the ordinal weighting method.

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Business Intelligence Using N-Beats And Rnn Methods End Influence On Decision Making In The Flexible Packaging Manufacturing

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Abstract – Today's complex decision-making solutions for intelligent manufacturing depend on the ability to be able to model a manufacturing system realistically, valid and consistent data integrated easily and in a timely manner, able to solve problems efficiently with computational effort to obtain optimal production and product quality optimizations continuously. When an organization uses a data-driven approach, it means that it makes strategic decisions based on data collection, analysis, and interpretations or insights. The purpose of this research is to analyze the business intelligence approach in optimizing print machines by speed, material and time. in this research, using the N-Beats is a deep neural architecture based on backward and forward residual links and a very deep stack of fully-connected layers and Recurrent Neural Networks (RNN). The novelty of this research is increasing machine speed using new insights by combining two deep learning methods. Observing and retrieving raw data from the printing machine process with sensors data for use and ensuring the justification of the addition of new methods. The result is expected to be able to provide new insights that can increase engine speed, the data based decision making provides businesses with the capabilities to generate real time insights and predictions to optimize their performance and provide confidence in decision making that are fast, precise and better.

Keywords – Business Intelligence, Recurrent Neural Networks, N-Beats, Decision-Making, Deep Learning, Insights

I. INTRODUCTION

To achieve genuine digital transformation, it is necessary to move beyond the asset-focused business intelligence approach and adopt a more holistic system that integrates Engineering, Operations, and Maintenance [1]. The increasing availability of data on volume, variety, and speed along with the increasing capabilities of computing and communications as well as the capabilities of modeling and solving complex analysis, is driving data into business using a combination of diverse and complementary types of process analysis [2]. The model possesses several desirable properties, including interpretability, adaptability to a wide range of target domains, and fast training. Two N-BEATS configurations, along with Recurrent Neural Network (RNN), were employed using the Python programming language. The problem that will be discussed in this research is how to optimize the printing machine production process using the N-Beats and RNN methods to analyze errors from the results of the model training process. To obtain the right parameters in an effort to speed optimized machine [3]. Focused on the three parameters generated by the machine sensor dataset, namely the type of material, speed and processing time and the process code for each machine unit [4].

The manufacturing industry is currently undergoing a paradigm shift due to the advancements in Big Data and Machine Learning (ML), which have now progressed to Deep Learning (DL) [5]. This transformation is moving the industry from the traditional manufacturing era to the intelligent manufacturing era 4.0, creating new opportunities. N-BETAS (Neural Basis Expansion Analysis for Interpretable Time Series Forecasting) [6]. The methodology for the architectural design of this system is based on a set of fundamental principles. Firstly, the architecture should be straightforward and versatile while still being comprehensive. Secondly, the architecture must not depend on feature engineering or input scaling that is specific to time series [7]. RNNs have been employed with success for various tasks that involve processing sequences of data such as sentiment analysis, machine translation, time-series forecasting, image captioning, and more [8].

II. RESEARCH METHODOLOGY

In the upcoming chapter, we will explain why quantitative methods were selected and how the empirical research was conducted. Then, we will outline the dataset retrieval design, which includes a brief introduction to the organizations involved in the thesis and the process of collecting the dataset from the machine. Finally, we will discuss the method analysis, the reliability of the research, and any criticisms of the chosen method.

A. Research Object

The purpose of this research is to improve the accuracy of forecasting predictions using the N-BEATS and RNN methods in computer models. The thesis focuses on these two models and aims to demonstrate their ability to generate new insights through prediction. The dataset utilized is comprised of engine sensor data in Txt format, which is stored in a SQL database. The data is then retrieved in CSV format, and the engine process data for the year 2021 is selected for use in the thesis. This section describes the proposed method for generating forecasting that can provide new insights by leveraging multiple parameters of sensor data. The model will process various parameters generated by the sensors to obtain effective forecasting predictions and extract insights from the data.

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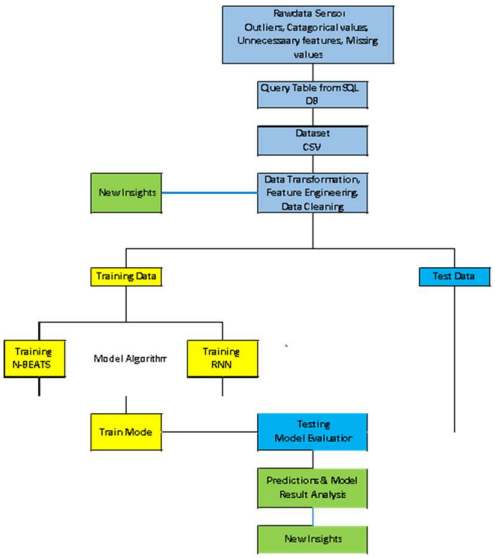

Figure 1 Flow Chart of Prosed Model and Implementation.

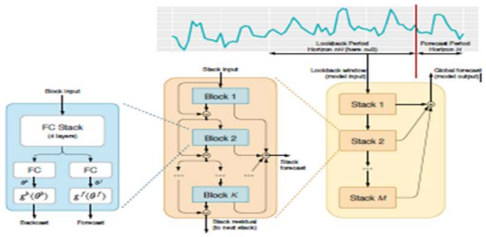

Figure 2 N-BEATS Architecture.

B. Predicting Forecasting by Machine

In this table, the "Model" column lists the names of the two models being compared. The other columns show the average values of different evaluation metrics for each model. The "RMSE" column shows the root mean squared error, the "MAE" column shows the mean absolute error, the "MSE" column shows the mean squared error, and the "SMAPE" column shows the symmetric mean absolute percentage error. In the Table 1, that shows the average results of the N-BEATS and RNN models for time series forecasting.

Table 1 Result of Predicting Forecasting by Material Types

Model	Types of Material	RMSE	MAE	MSE	SMAPE	AVG.
N-Beats	Material1	0,187	0,149	0,035	28,2%	20,0%
	Material2	0,242	0,182	0,059	81,7%	20,0%
	Material3	**0,233**	**0,188**	**0,054**	**84,6%**	**20,0%**
RNN	Material1	0,061	0,045	0,004	6,0%	10,0%
	Material2	**0,212**	**0,167**	**0,045**	**29,9%**	**20,0%**
	Material3	0,186	0,15	0,035	24,0%	20,0%

C. Prediction Accuracy Measures

The Root Mean Squared Error (RMSE) and the Mean Average Percentage Error (MAPE) are used to assess a models price predictions adequacy. These measures have also been used by many other studies.

$$MAPE = \frac{1}{T}\sum_{i=1}^{T}\left|\frac{d_i - \hat{d}_i}{d_i}\right| \times 100 \quad (1)$$

III. Results And Discussion

The models used in this study achieved relatively good performance in terms of prediction accuracy. This means that the models developed are able to produce predictions that are close to the true value with a low error rate. In the study, the evaluation results showed that the models had good accuracy and were able to produce accurate predictions. With relatively good performance, the models can provide valuable insights and information in decision-making in the flexible packaging manufacturing industry. However, the N-BEATS model is superior in terms of prediction accuracy with lower mean values across all evaluation metrics. The results from both models provide valuable insights that can be used in optimizing press speeds in rotogravure printing processes. By identifying the optimal parameters based on the model predictions and increasing the output, companies can improve their productivity and process efficiency. In other words, the use of N-BEATS and RNN models in Business Intelligence analysis enables flexible packaging manufacturing companies to make informed decisions to improve the performance and effectiveness of their presses.

The use of Business Intelligence (BI) in the flexible packaging manufacturing industry has significant benefits [9]. With BI, companies can take better decisions based on accurate data analysis and easy-to-understand visualizations. This helps in understanding market trends, predicting product demand, and responding quickly. In addition, BI also enables cost reduction by identifying areas of waste and improving efficiency in the production process [10]. With product quality analysis, companies can improve quality and reduce defects through quick corrective actions. Finally, BI helps improve a company's competitiveness by providing deep insights into markets, customers, and competitive advantages [11]. Sbrana et al., (2020) This enables companies to take the right steps to meet customer needs and achieve an edge in the flexible packaging market.

1. Business Intelligence (BI) plays an important role in optimizing presses for speed by providing the insights and information needed to improve efficiency and productivity. Here are some of the ways BI can optimize presses based on speed:
2. Data Collection and Integration: BI involves collecting data from various sources such as press sensors, production logging systems, and other systems related to press speeds. This data is then integrated into a single BI system or platform for more holistic analysis.
3. Data Analytics: Through BI data analysis, patterns and trends related to press speeds can be identified. This analysis can involve statistical techniques, predictive modeling, and machine learning algorithms to unearth deep insights into the factors affecting press speeds.
4. Performance Monitoring: BI enables real-time monitoring of press performance. Actual speed data is collected and compared with set targets. If there is any deviation or drop in performance, BI provides notifications or reports that enable the operations team to take quick corrective actions.
5. Process Optimization: Using insights from BI,

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companies are able to identify the causes of printing press speed non-optimization. This allows them to optimize the production process by making necessary operational improvements or adjustments. For example, BI can help in identifying bottlenecks, organizing an efficient task sequence, or adjusting machine settings.

6. Planning and Decision Making: BI also helps in long-term planning by providing the information needed for strategic decision-making related to investments in new equipment, preventive maintenance, or changes to more efficient production processes. With a better understanding of press speeds and the factors that affect them, companies can make smarter decisions to improve performance and productivity.

Through the application of BI in press management, companies can gain better visibility, identify opportunities for speed improvements, and take the necessary actions to optimize production processes. Thus, BI can help companies achieve higher efficiency, reduce production costs, increase output speed, and bring significant added value [13].

Business Intelligence (BI) plays an important role in optimizing material-based molding machines by providing the information and insights needed to improve production efficiency and quality [14]. Zeng et al., (2021) here are some of the ways BI can optimize presses by material:

1. Material Availability Analysis: Using BI data, companies can analyze the availability of materials required for the print process. This data includes material inventory, delivery time, and supplier capabilities. By looking at the data, companies can predict future material demand and optimize inventory so that the production process is not interrupted by material shortages [16].
2. Material Inventory Management: Using BI analysis, companies can optimize material inventory arrangements. For example, by looking at historical demand data and market trends, companies can determine the optimal inventory levels for each type of material [17]. This helps avoid wastage and excessive storage costs, while ensuring materials are available on time for production.
3. Material Quality Monitoring: BI can help in monitoring the quality of materials used in the molding process. Quality data and indicators can be collected and analyzed in real-time to detect any discrepancies or defects in the materials. Thus, companies can take immediate corrective actions, reduce the risk of defects in molded products, and increase customer satisfaction.
4. Material Efficiency Analysis: BI can help companies identify factors that affect material utilization efficiency. Data collected from molding machines and other production systems can be analyzed to identify possible waste, material loss, or imperfections in the production process. By understanding the patterns and causes of material wastage, companies can take action to optimize material usage and improve production efficiency [18].
5. Planning and Decision Making: Using BI, companies can make better plans related to material procurement, supplier selection, and inventory management. BI data and analysis help in making strategic decisions related to materials, such as evaluating new suppliers, looking for more efficient material alternatives, or adjusting material procurement strategies based on market trends.

Business Intelligence (BI) can help optimize presses based on time by providing deep insights into press performance, real-time monitoring, and historical data analysis. Bulatov, (2020) here are some of the ways BI can be used to optimize presses over time:

1. Molding Machine Performance Monitoring: BI enables companies to monitor press performance in real-time. Operational data such as print speed, downtime, and reset time can be collected and analyzed in real time. This helps in identifying possible performance issues, such as unplanned downtime or low print speed. With proper monitoring, companies can take quick corrective actions and optimize the uptime of the press.
2. Downtime Analysis: Downtime is the time during which a press is not operating. Using BI analysis, companies can identify the causes and duration of downtime, both planned and unplanned [4]. This data can help in optimizing routine maintenance schedules and minimizing unnecessary downtime. In addition, downtime analysis also helps companies identify contributing factors and take preventive actions to reduce downtime in the future.
3. Demand Prediction: Through the analysis of historical data and market trends, BI can help companies predict future demand for printed products. This information allows companies to conduct [20] better production planning, optimize production schedules, and avoid situations where presses experience idle time or overload. By predicting demand with greater accuracy, companies can optimize the use of printing presses and avoid wasting resources.
4. Production Efficiency Analysis: BI allows companies to analyze production efficiency based on time. Operational data and production parameters such as cycle time, preparation time, and reset time can be analyzed to identify areas where efficiency can be improved. For example, companies can evaluate the optimal cycle time for each printed product or identify activities that take too long in the production process. With this analysis, companies can optimize the use of time and increase the productivity of the printing press.
5. Production Planning and Scheduling: BI helps in efficient production planning and scheduling. By collecting and analyzing time-related data, BI enables companies to create better production schedules based on press capacity, product demand, and resource availability [21]. This helps

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avoid production time imbalances that can result in machine overutilization or underutilization.

IV. CONCLUSION

Both models achieved relatively good performance in terms of prediction accuracy. The N-BEATS model outperformed the RNN model in terms of prediction accuracy, with lower average values across all evaluation metrics. The insights gained from these models can be used to optimize machine speed in the rotogravure printing process. By identifying the optimal parameters and increasing the output, the productivity and efficiency of the process can be improved. For future work fine-tune hyperparameters such as learning rate, batch size, number of layers, and number of neurons can significantly affect the performance of the models. Future work can explore different hyperparameters to find the best combination for the given dataset.

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The Knowledge Management Model to Support Academic Activities at SD Al-Imam Islamic School Cileungsi Using the Seci Approach

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Abstract *− The absence of a processing model, knowledge storage due Knowledge in the form of notes, files, pictures and so on disappears because 17 teachers dump themselves and bring knowledge, files, notes that ever made. Allegedly with the creation of a processing model, knowledge-based storage a website with a SECI approach can provide a managed solution with good knowledge at SD Al-Imam Islamic school." In this study, the authors develop model knowledge management system that is in accordance with the conditions that exist in SD Al-Imam Islamic School, knowledge formation using the SECI model. From the results of testing the experimental system knowledge management system using the Technology Acceptance Model (TAM) method the average result is above 58%, which means that the respondent is in doubt about the application of the system tried the knowledge management system at SD Al-Imam Islamic School.*

Keywords *– Knowledge Management, SECI, TAM.*

I. INTRODUCTION

The development of science and technology in this era of globalization is happening very fast. The scientific ability of an educational institution is one of the most important factors for present and future progress. When aneducational institution or school tries to develop its knowledge scale, a very broad level of knowledge is needed to be able to share knowledge. This knowledge management concept includes the management of human resources (HR) and information technology (IT) toachieve better educational institutions. To facilitate the development of human resources in an educationalinstitution, it is necessary to have the ability to manage and develop the knowledge they have. Management of Knowledge (Knowledge Management) can ultimately be areliable support for an educational institution to increase its knowledge[1],[2]. SD Al-Imam Islamic School activities include academic, non-academic, and student affairs. In academic implementation, it requires Standard Operational Procedures, Rules, Forms and Monitoring of its implementation. This needs to be socialized to all old and new teachers. The existence of 17 old teachers who resigned in the 2022/2023 academic year, namely July 2022 – July 2023 (teacher data is available on the attachment page) caused a lot of knowledge information such as Implementation of Learning and Student Problemsin Class [3],[4] and so on not to be found because it had been brought in by teachers who have withdrawn and cannot beknown by new teachers, this causes a lot of information and knowledge in the form of files, notes and paper prints to be unable to be found and this raises repeated questions from time to time.

From these problems the Foundation has provided a School Web Profile (https://alimamischool.com/) to introduced by Nonaka and Takeuchi who are composed on Tacit Knowledge and Explicit Knowledge has a process of socialization, externalization, combination and internalization. SECI Model implementedwithin the scope of Face-to-Face, Peer-to-Peer, Group-to-Group, and On the Site[5],[6],[7]. (2) Intellectuals Capital, is a model introduced by

Edvinsson which consists of Human Capital (Human resources, intellectual assets, intellectual property), Business Assets (Complementary Assets), Structural Capital (organizational assets, intangible assets). For process and scope of implementation are implicit. (3) OK Net, this model was introduced by Carayannis which consists of State of Knowledge and state of Knowing (knowledge and meta-knowledge).

The process of this model includes Knowledge creation, Knowledge securing, knowledge distribution, Knowledge retrieval. (4) Ecology of KM, a model that introduced by Snowden it consists ofExplicit/Tacit Knowledge, Knowledge Assets, Trusts, decision. The processes in this model are: Knowledge mapping, competency creation, tacit knowledge management, intellectual capital system.

The scope of implementation of this model is implicit. (5) Taxonomy of KM, this model is introduced by Despres & Chauval which consists of Tacit Knowledge and Explicit Knowledge. Process inside This model is Scan-map, capture-create, package store, share-apply, transforminnovate[8]. Scope the implementation of this model is Implicit: on site and virtual.For this reason, an integrated solution is needed to manage all information and knowledge related to academics so that all parties who need it can understand and access it easily. The application of knowledge management can properly manage existing information and knowledge so that all forms of information and knowledge can be conveyed to old teachers and new teachers through appropriate media. Therefore this writing will build a knowledge

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management to answer the problems above.

From the background explanation regarding some of the problems discussed above, the problems that can be formulated are as follows:

"There is no processing model, knowledge storage because knowledge in the form of notes, files, images and so on disappears because 17 teachers resign and bring knowledge, files, notes that were previously made."

From the description of the research problems that have been discussed above, the research objectives that can be formulated are as follows:

"Provide solutions in the form of processing models, knowledge storage at SD Al-Imam Islamic School."

In a study, it is necessary to support the results of previous studies related to this research. The following isa study review that supports this research, which can be seen in table 1 below.

Table I. Journal References

No	Peneliti	Judul	Penjelasan dan Hasil	Metode
1.	RISALINA, (2022) [12]	KNOWLEDGE MANAGEME NT MODELS IN IMPROVING PERFORMAN CE PT. KL JAKARTA	The results that have been obtained indicate that the answers from the respondents have met the suitability requirements and the model made has been proven to be good in terms of sensitivity or stability. The Knowledge Management Model in this study shows the importance of Passive Public Knowledge to improve performance at PT KL.	(1) Passive Public Knowledge (2) Active Public Knowledge, 3. (3) Passive Share 4. Knowledge, (4) Active Share Knowledge, (5) Passive Personal Knowledge, dan 7. (6) Active - Personal Knowledgde.
2.	Imadudin Abdan Syakuro (*Skripsi*. FST, Sistem Informasi, UIN Sya rif Hidayatullah Jakarta, 2021) [10]	Design and Build a Website Repository-Based Knowledge Management System (Study Case : LAMPUNG PROVINCE BAPPEDA)	BAPPEDA Lampung Province which is engaged in regional planning and development is managed and disseminated between each employee so that it requires a place to easily manage and share data to minimize errors that may occur. From the research results, a website-based system is able to help employees to be able to store and manage knowledge.	- The system has - Download feature to make it easier for each employee to have separate data
3.	Novi Sofia Fitriasari , Dhea Rahma Azhari, Muhammad Ghifari Shafa, Amien Rais, Taufiq Ejaz Ahmad, (2020) [11]	KNOWLEDG E MANAGEME NT SYSTEM MODELS IN MARINE INFORMATIO N SYSTEMS STUDY PROGRAM	The KM Technology Element produces a knowledge management system application (ASMAPE) and the Knowledge Artifact Element produces explicit knowledge from a knowledge worker, this knowledge consists of the domains of Information Systems, Fisheries, Geographic Information Systems, Ocean Remote Sensing and Ocean Sciences.	- The research method is carried out by applying the KMS Model which consists of 5 pillars namely Organization, KM Team, KM Process, KM Technology and Knowledge Artifacts.
4.	Eko Retno Wulandari dan Risa Nurisani, (2020) [9]	Knowledge Management Model at Padjadjaran University Library	The results of the study obtained a proposed model of the Knowledge Management process at the Padjadjaran University Library, namely knowledge creation, knowledge acquisition, knowledge storage. knowledge) knowledge sharing (knowledge sharing)	- qualitative method as a research procedure that produces descriptive data in the form of observable written or spoken words. According to them, this approach

II. RESEARCH METHODOLOGY

A. Types of Research

This type of research used is to use a qualitative approach. The data collection method used in the initial research was limited to the results of interviews, observations, literature studies and analysis of documents related to research or what is commonly called the descriptive method at SD Al-Imam Islamic School Cileungsi, Bogor Regency.

This research is development research or referred to as Research & Development which was carried out to find out and develop and provide results on the Knowledge Management System to increase effectiveness at SD Al-Imam Islamic School Cileungsi, Bogor Regency, especially for teachers to improve HR competence by having old knowledge makes newer knowledge, superior and competitive..

B. Data Collection Methods

The method that the author uses in data collection is carried out to obtain the information needed in the research as follows:

a. Interview

The interview was conducted at SD Al-Imam Islamic School Cileungsi, Bogor Regency with the Principal Muhamad Fadli, M.Pd. and one of the teachereducators on December 2, 2022. Interview activities were carried out by researchers with discussions and questions and answers regarding the needs of this research. The interviews were conducted with the aim of obtaining data and information, especially regarding the constraints that often occur. The records of the interview results can be seen in the attachment. Based on the results of interviews with 13 teachers who agreed to be interviewed, from the questions that have been asked it can be concluded that "individuals socialize with each other and share experiences through weekly meetings" then teachers must write ideas, make models and analogies and document them in the form files.

b. Observation

Researchers made observations with the aim of knowing the Knowledge Management work process and knowing the condition of the school, organizational structure, school history, vision and mission of the school.

1. Research Location

In carrying out this research, the authors conducted research at SD Al-Imam Islamic School Housing Limus Pratama Regency, Cileungsi, Bogor Regency.

2. Visited section

At the time of the observation, the researcher visited the principal who has full authority at the school and one of the teaching teachers to find out the knowledge management system contained in SD Al-Imam Islamic School Cileungsi, Bogor Regency. The results obtained during the observation are:

"First, the researcher knows tacit data management in the form of experiences carried out during interviews which is attached in Appendix I regarding interviews and the researcher knows that explicit data in the form of data on the completeness of Learning Implementation and Child Problems in Class willbe included in the Application."

3. Sampling

Questionnaire sampling was carried out for all old and new teachers and school principals. In the 2022/2023 academic year the total number of individuals is 13 people, for the need to fill in the questionnaire no sample selection was carried out because the number was small. The following arethe

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names of the teachers according to table 1.

Table 2. Sampling

Nama	Jabatan
Umi Salamah, S.Pd.	Guru
Heni Mariyah Umroh S.Pd	Guru
Wiwin Wulandari S.Pd.	Guru
Dewi Fitria Nugraheni S.Pd	Guru
Tri Yuli Aryani S. Pd	Guru
Tri Nuryani S.S	Guru
Adam Abdurohman Saleh, S.Pd. Jas	Guru
Aning Nurhayati ST	Guru
Sumiati S.Pd	Guru
Afifah Ridzki Mulianti S. Pd	Guru
Windy Maylanasari, S.Pd	Guru
Eniang khoeruman abdul madjid	Guru
Aisyah Fauziah S.Ag	Guru

C. Research Steps

The steps of the research methodology can be described as in Figure 2 below.

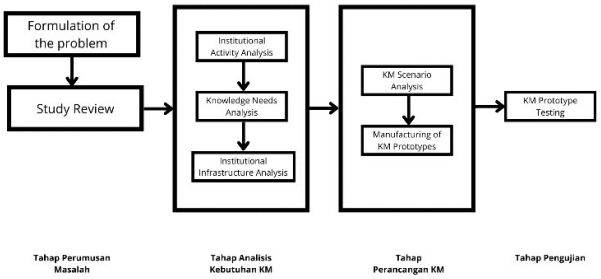

Image 2. Research Steps

III. RESULTS AND DISCUSSION

A. Knowledge Management System Scenario Analysis Every activity in SD Al-mam Islamic

In order to create and formulate knowledge, schools need

No	Activities	Implementation	Process KnowledgeManagement
1	Setting StandardsImplementation of Learning	- Sharing document - Meeting - Discussion	- Sosialisation - Eksternalisation - Kombination - Internalisation
2	Carry out the planschool activities and budgetAl-Imam Islamic School	- Meeting - Sharing knowledge	- Eksternalisation - Internalisation
3	Coord natewith the teacher about notes during learningin the classroom	- Meeting - Sharing knowledge	- Eksternalisation - Internalisation
4	Record events andstudent problems in classuseful as materialevaluation for all teachersboth old and new.	- Meeting - Sharing knowledge	- Eksternalisation - Internalisation
5	Carry out the planschool activities and budgetAl-Imam Islamic School	- Sharing document - Meeting - Discussion	- Sosialisation - Eksternalisation - Kombination - Internalisation
6	Coord natewith the teacher about notes during learningin the classroom	- Meeting - Sharing knowledge	- Eksternalisation - Internalisation

to cycle the knowledge management process which consists of four stages according to the SECI model as shown in table 3.

From the relationship above, a knowledge management system scenario can be formed to support activities and improve the services of SD Al-Imam Islamic School teachers, which is a form of the SECI model, as shown in Figure 3.

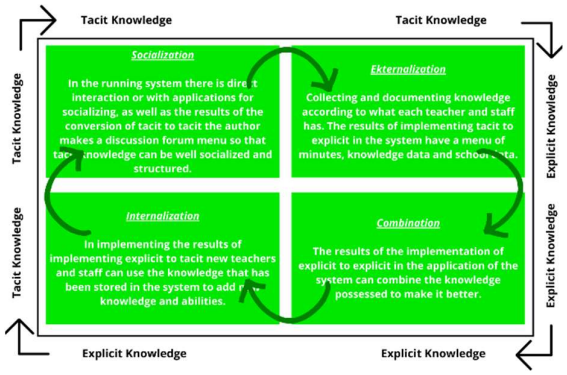

Table 3. Process of Knowledge Management SD Al-Imam Islamic SchoolSocialization

The process of socialization is the process of being able to change tacit knowledge into tacit again. Features that support this process are e-mail, chat, and discussion. This process becomes easier and faster because teachers wait for each other to meet in person to discuss solving a problem.

1. Externalization

   The externalization process is a process that can change tacit knowledge to explicit. This feature can support this process is an electronic discussion,because by using this feature all ideas, experiences andknowledge can be written in the discussion forum,which in turn can be read by other assistants.Electronic discussions can also be divided into several discussions, such as Friday meetings, event committee meetings, regulations, socialization of activities and soon so that users can immediately access the required themes.
2. Combination

   The combination process is a process carried out to change explicit knowledge into explicit. Features that support this process are document management carried out by school principals and teachers, this aims tomake it easier to make certain changes and can also provide new explicit knowledge to storage locations that can be easily accessed by other assistants.
3. Internalization

   The process of internalization is the process of converting explicit knowledge into tacit. Features that can support this process are electronic discussions and document management. The internalization process can be facilitated by electronic discussion or chat because each teacher can express their ideas or suggestions which other teachers can read directly. Document management can also help the internalization process because teachers can easily findor get lesson learned that has been documented in storage, knowledge management processes andtechnology.

B. Knowledge Management System Model Design Based on the results of the knowledge process analysis

Management and technology to be obtained, the next step is to plan a knowledge management system model at SD Al-Imam Islamic School. Figure 4 is a Knowledge

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Management System model at SD Al-Imam Islamic School.

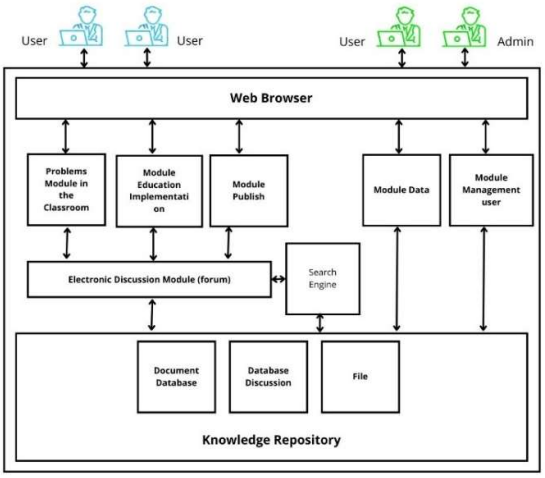

Fig 4. Knowledge Management System Model Design

C. Validity Test

The item validity test is a data instrument test to find out how carefully an item measures what it wants to measure. The validity test was carried out using SPSS version 26, determining whether an item was valid or not was carried out by comparing the calculated r value in the corrected Item-Total Correlation column with the pearson Product moment r table value. If the calculated r value is greater than the r table value, then the item is said to be valid. Conversely, if the calculated r value is less than the r table value, then the item is declared invalid, so it must be corrected or discarded. The r table value is searched with df = N-2 = 13-2 = 11, then the r-table value is 0.4762. The results can be seen as in table 4.

Table 4. Validity Test Result

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
ITEM_1	44.3846	279.256	.988	.	.978
ITEM_2	44.3846	279.256	.988	.	.978
ITEM_3	44.3846	279.256	.988	.	.978
ITEM_4	44.3846	279.256	.988	.	.978
ITEM_5	44.1538	284.641	.848	.	.980
ITEM_6	44.3077	277.397	.977	.	.978
ITEM_7	43.9231	291.410	.709	.	.982
ITEM_8	44.3846	279.256	.988	.	.978
ITEM_9	44.0000	287.500	.756	.	.982
ITEM_10	44.1538	284.641	.848	.	.980
ITEM_11	44.0000	294.167	.676	.	.983
ITEM_12	44.3077	277.397	.977	.	.978
ITEM_13	44.0769	296.077	.664	.	.983
ITEM_14	44.1538	278.808	.902	.	.979

From the test results it is known that the r-table value is greater than the Corrected Item – Total Correction value, so it can be concluded that the questions asked are valid.

D. Reliability Test

Reliability is a measuring tool that is said to be reliable if the tool in measuring a phenomenon at different times always shows the same results. The reliability test is a continuation of the validity test, where the indicators that enter the test are only valid indicators. A variable is said to be reliable if it gives a Cronbach's Alpha value > 0.60.

Table 5. Realibility Test Result

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.981	.981	14

In Figure 5 it can be seen that Cronbach's Alpha is 0.981, the value is > 0.60. So it can be said that the statement items submitted have the reliability that is received.

E. Knowledge Management System Prototype Testing

System testing is carried out to test the level of software quality using the TAM (Technology Acceptance Model) method with several variables, namely: Perceived Usefulness, Perceived Ease of Use, Attitude Toward Using, Behavioral Intensity Use (Behavioral Intention to Use), Actual System Use (Actual System Use). This test iscarried out on the client side of the use of the system. The criteria for selecting respondent characteristics as aresearch sample for testing the quality of this software are based on the level of users who will access thisapplication. The respondents were school principals, old and new teachers at SD Al-Imam Islamic School. ThroughFocus Group Discussion (FGD) which was attended by

Aspect	Prestation Value	Average	Information
Setting StandardsImplementation of Learning	251%	63%	Agree
Carry out the planschool activities and budgetAl-Imam Islamic School	159%	53%	Hesitated
Coordinatewith the teacher about notes during learningin the classroom	171%	57%	Hesitated
Record events andstudent problems in classuseful as materialevaluation for all teachersboth old and new.	108%	54%	Hesitated
Carry out the planschool activities and budgetAl-Imam Islamic School	65%	65%	Agree

old and new teachers, which was preceded by a presentation by the researcher.

Table 6. Test Result Recapitulation Table

Based on table 6, the recapitulation of the results of software testing on the knowledge management system is obtained as follows: in the Perceived Usefulness aspect, an average value of 63% is obtained and is included in the criteria of strongly agreeing, meaning that respondents think that the perception of the usefulness of thisknowledge management system is considered very good.

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In the Perceived Ease of Use aspect, an average value of 53% is obtained and is included in the doubtful criteria,meaning that respondents think that the perceived ease of use of this knowledge management system is stilldoubtful.

In the Attitide Toward Using aspect, an average value of 57% is obtained and is included in the doubtful criteria, meaning that respondents think that the perception of the attitude towards using the knowledge management systemis not yet acceptable to respondents.

For the Behavioral Intention to Use aspect, an average value of 54% is obtained and is included in the doubtful criteria, meaning that respondents are hesitant to use theknowledge management system that will be implemented. For the Actual System Use aspect, an average value of 65% is obtained and is included in the Agree criteria, meaning that respondents in fact use the knowledgemanagement system intensity to use the proposed knowledge management system continuously.

From the test results of the proposed knowledge management system, the average result is above 58%, which means that respondents are doubtful about the implementation of the proposed knowledge management system.

IV. CONCLUSION

In this study, the authors developed a knowledge management system model that is inaccordance with the existing conditions at SD Al-Imam Islamic School, forming knowledge using the SECI modfocus nly el. From the results of testing the proposed knowledge management system using the TAM (Technology Acceptance Model) method, the average result is above 58%, which means that respondents are doubtful about implementing the proposed knowledge management system at SD Al-Imam Islamic School.

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Determination of Candidates for Madrasah Aliyah Student Scholarships Using The Simple Additive Weighting Method

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Abstract – Scholarships are a facility expected by some students who need financial assistance in their education. Case study research at MAN 3 Tangerang as a state Islamic senior high school, MAN 3 Tangerang has facilities to propose students who have achievements and need educational funding assistance to the Indonesian Ministry of Religion (Kemenag). Schools often find it difficult to determine which prospective students are most eligible for scholarships. This research is to help the school design and develop a decision support system (DSS) application with the Simple Additive Weighting (SAW) method. DSS application built using UML design and PHP (Hypertext Processor File) programming with MySQL database. The resulting DSS application has been able to provide a sequence of data for prospective scholarship recipients according to the criteria and weightings that have been set. Based on the data generated by the system, the principal can make a decision on who is entitled to a scholarship from the Ministry of Religion (Kemenag).

Keywords – DSS, Scholarship, Student, Islamic Senior High School, SAW

I. INTRODUCTION

Getting a good education is one of the most basic human rights as stated in the 1945 Constitution. By getting a good education, will make a person get a better life. Scholarships are the provision of financial assistance to high-achieving and underprivileged students from a government or private institution. Scholarships aim to help students take their education to completion [1], [2].

In every educational institution, especially senior high school, there are a lot of scholarships offered to high-achieving and disadvantaged students[3]. There are scholarships that come from government and private institutions. To get the scholarship, students must go through a selection phase in accordance with the established rules. Likewise, in MAN 3 Tangerang school, where currently there is a scholarship program that has been distributed by the Ministry of Religion to students according to established criteria, this is one of the jobs of the school administration system. The administration system is one of the activities that must be present in the activities of an organization [4] [5].

In this study, researchers conducted the process of designing and developing DSS applications. A decision support system is a computer-based system, consisting of three interacting components, a language system, a knowledge system, and one or more problem processing systems with general problem manipulation capabilities needed for decision-making [6], [7]. Decision making is the act of choosing among various alternative solutions to problem solving [8]. Decisions are defined as choices and it is often necessary to make many decisions in the process of solving one problem .

Based on the background above, it can be identified several issues related to the decision making process of submitting prospective scholarship recipients in MAN 3 Tangerang.

Problems are as follows:

1. What methods are used to help make a decision to determine the Submission of Prospective Student Scholarship Recipients at MAN 3 Tangerang?
2. Are there any difficulties in entering and processing data on the submission of prospective scholarship recipients in MAN 3 Tangerang?
3. What are the difficulties faced by schools in determining who are the scholarship recipients in MAN 3 Tangerang?

In the research conducted by the author, the author limits the problem to the design and development of decision support systems (DSS) with the criteria used in which these criteria are criteria that have been applied in MAN 3 Tangerang with a predetermined weighting, and using the Simple Additive Weighting (SAW) method. DSS SAW method is suitable to be applied to solve selection problems with many criteria and alternatives [9], [10].

This research uses the waterfall model, which illustrates a systematic and sequential approach to software development, starting with the specification of user needs and then continuing through the stages of planning, modeling, construction, as well as the delivery of the system to the customer/user (deployment), which ends with support for the complete software produced [11], [12].

The application developed also displays graphics as a dashboard that can be used as a tool to analyze the results of the process. Analysis of the results is needed by top management of each organization to visualize, analyze and prepare for strategic planning in the future [13], [14].

II. RESEARCH METHODOLOGY

This research applies a mixed research method (quantitative & qualitative), where data gathering will be carried out by conducting surveys and interviews using a list of questions and direct interviews with related parties. The research method above is a mixed research method, which is a research method that combines quantitative methods and qualitative methods [15], [16].

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The researcher uses the SDLC (Software Development Life Cycle) cycle which is a systematic and sequential approach method starting at the level of system analysis to be developed and then moving on to the system design, system implementation, testing, and maintenance stages. Figure 1 shows the stages of research carried out in this study.

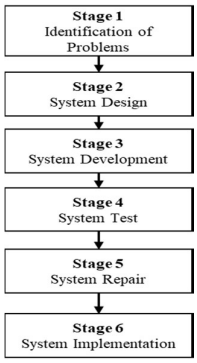

Figure 1. Research stages

2.1. Identification of Problem

At this stage the researchers communicated with the resource persons, namely the staff of MAN 3 Tangerang who took care of the selection process and student scholarship applications. From the results of the staff discussion, it was difficult to determine which students were most entitled to receive scholarships because there was no method of calculating points based on the criteria for scholarship candidates who were most entitled to receive scholarships.

At the problem identification stage, the researcher collected data with two methods:

A. Sample Selection Method

The selection of sample respondents is based on consideration of the criteria for the respondent in accordance with the duties and responsibilities involved in assisting the selection process of prospective scholarship recipients. The respondents referred to above are: School principal, Administrative leader and Counseling teacher.

B. Data Collection Method

Data collection methods used in this study are:

1. Interview Method.
   Researchers have interviewed all respondents to ascertain all problems and problems in the process of determining the scholarship recipients.
2. Survey Method.
   Researchers have prepared a list of questions related to the process of determining the scholarship recipient candidates then the authors distribute the list of questions to be filled and analyzed.
3. Observation Method.
   Researchers also conduct direct observation of the object of research in order to collect data to strengthen data collection activities that have been done previously through interviews and surveys.
4. Literature Study Methods.
   Researchers collect data by studying, researching, and reading books, journals, theses, and theses related to the DSS Build designation for determining scholarship recipient submissions.

2.2. System Design

At this stage, the application design modeling will be developed using the Unified Modeling Language (UML). The design of the use case of the information media application for the Informatics Engineering study program at the Muhammadiyah University of Tangerang which was developed. UML is used because it can provide a general vocabulary of object-based terms and a large number of diagramming techniques for the purposes of modeling any information system development and design project [17], [18].

A. Use Case Diagram

Use cases are narratively used to textually describe the sequence of steps of each process.

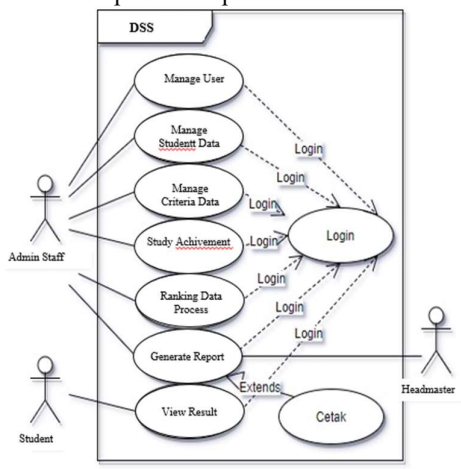

Figure 2. Use case diagram

B. Class Diagram

Class diagram describes the structure of the system in terms of defining the classes that will be created to build the system. Classes have what are called attributes and methods or operations.

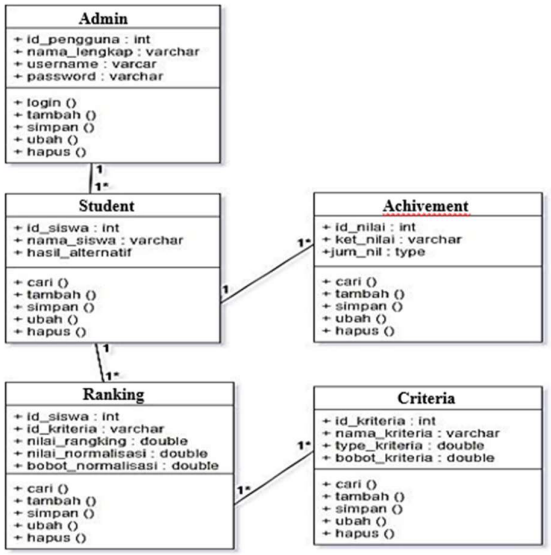

Figure 3. Class diagram

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2.3. System Development

The next process researchers develop a system using the programming language PHP framework laravel. After the application has been developed, the researcher tests the system using black box testing. The DSS development process uses the SAW method with the following steps:

a. Determine Alternatives (Ai).
b. Determine the criteria that will be used as a reference in decision making (Cj).
c. Determine the weight of preference or level of importance (W) for each criterion.
d. Determine the Match Value for each criterion.
e. Make a decision matrix (X) obtained from the match rating on each alternative (Ai) with each criterion (Cj).
f. Perform the decision matrix normalization step (X) by calculating the value of the normalized performance rating (rij) of alternatives (Ai) on the criteria (Cj).

$$Rij = \left(\frac{Xij}{Max\ Xij}\right) \quad Rij = \left(\frac{Min\ Xij}{Xij}\right)$$

g. The results of normalization (rij) form a normalized matrix (R).

$$R = \begin{bmatrix} R11 & \cdots & R1j \\ \vdots & \ldots & \vdots \\ Ri1 & \cdots & Rij \end{bmatrix}$$

h. The final result of the preference value (Vi) is obtained from the sum of the multiplications of normalized matrix row elements (R) with preference weights (W) corresponding to the matrix column elements (W).

$$Vi = \sum_{j=1}^{n} Wj\ Rij$$

Vi = Final value of the alternative
Wj = Weight that has been determined
Rij = Normalization matrix

A greater value of Vi indicates that alternative Ai more elected.

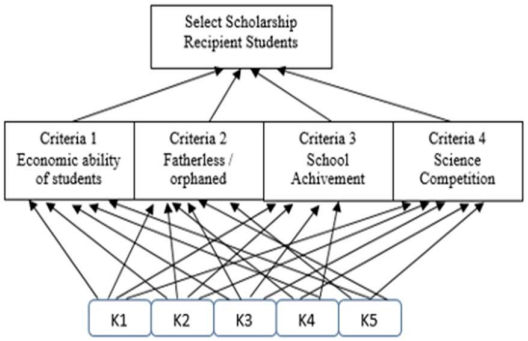

Figure 4. Alternative Hierarchical Structure of SAW

2.4. System Test

System testing uses the black box testing method where testing is based on application details, including the appearance of the application, the functions contained in the application, and the suitability of the function flow as required by the user.

2.5. System Repair

This stage is the stage of improving modules and functions that are deemed unable to meet user needs based on trials that have been carried out at the system testing stage.

2.6. System Implementation

The last stage carried out is the system submission stage, after the application has been developed and tested, the researcher provides training on the use of information systems.

III. RESULTS AND DISCUSSION

1. The following are the criteria needed to determine scholarship recipients at MAN 3 Tangerang:

Table 1. Economic Ability of Students

Criteria	Range	Scale	value
Economic ability of students	poverty level 60% (extremely poor)	1	0.2
	poverty level 70% (poor)	2	0.3
	poverty level 80% (not poor)	3	0.4
	poverty level 90% (rich)	4	0.5
	poverty level 90% (very rich)	5	0.6

2.

Table 2. Fatherless / Orphaned

Criteria	Range	Scale	value
Fatherless or orphaned	child who lost his/her father 80%	1	0.4
	child who lost his/her mother 90%	2	0.5
	child who lost his/her father and mother 100%	3	0.6

Table 3. School Achievement

Criteria	Range	Scale	Value
School Achievement	5th place in school 60%	1	0.2
	4th place in school 70%	2	0.3
	3th place in school 80%	3	0.4
	2nd place in school 90%	4	0.5
	1st place in school 100%	5	0.6

Table 4. Science Competition

Criteria	Range	Scale	Value
Science Competition	Do not have 60%	1	0.2
	Have sub-district level achievements 70%	2	0.3
	Have city-level achievements 80%	3	0.4
	Have province level achievements 90%	4	0.5
	Have national level achievements 100%	5	0.6

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2. The following is an example of calculating 10 students data:

Tabel 5. Student Grades for Each Criterion

No	Student Name	Criteria			
		I	II	III	IV
1	Siti Komala	90	100	100	70
2	Mulyanah F	80	100	100	70
3	Azmi I.R	80	90	90	60
4	Arif R	80	80	80	80
5	Hermawan	70	90	100	60
6	Debi P.S	80	80	90	60
7	Ratu D	80	80	80	80
8	Almas R	70	90	100	60
9	Diah Nur	80	80	90	60
10	Dwi Puspa	70	90	100	60

Tabel 6. Match Rating

No	Student Name	Criteria			
		I	II	III	IV
1	Siti Komala	0.5	0.6	0.6	0.3
2	Mulyanah F	0.4	0.6	0.6	0.3
3	Azmi I.R	0.4	0.5	0.5	0.2
4	Arif R	0.4	0.4	0.4	0.4
5	Hermawan	0.3	0.5	0.6	0.2
6	Debi P.S	0.4	0.4	0.5	0.2
7	Ratu D	0.4	0.4	0.4	0.4
8	Almas R	0.3	0.5	0.6	0.2
9	Diah Nur	0.4	0.4	0.5	0.2
10	Dwi Puspa	0.3	0.5	0.6	0.2

3. Based on the match table above then the researcher makes the matrix into **the decision matrix as the matrix below:**

$$X = \begin{bmatrix} 0.5 & 0.6 & 0.6 & 0.3 \\ 0.4 & 0.6 & 0.6 & 0.3 \\ 0.4 & 0.5 & 0.5 & 0.2 \\ 0.4 & 0.4 & 0.4 & 0.4 \\ 0.3 & 0.5 & 0.6 & 0.2 \\ 0.4 & 0.4 & 0.5 & 0.2 \\ 0.4 & 0.4 & 0.4 & 0.4 \\ 0.3 & 0.5 & 0.6 & 0.2 \\ 0.4 & 0.4 & 0.5 & 0.2 \\ 0.3 & 0.5 & 0.6 & 0.2 \end{bmatrix}$$

4. The results of the calculation of the value of Vi of each student who will get the submission of prospective scholarship recipients can then be made **a table determining the ranking of results as follows:**

Table 7. The Final Ranking

No	Student Name	Value	Ranking
1	**Siti Komala**	**96.25**	**1**
2	Mulyanah F	90.2500	2
3	Azmi I.R	77.3333	3
4	Arif R	75.6667	4
5	Ratu D	75.6667	5
6	Almas R	75.5000	6
7	Dwi Puspa	75.5000	7
8	Hermawan	75.5000	8
9	Debi P.S	72.3333	9
10	Diah Nur	72.3333	10

5. The following is the DSS Submission Determination of Prospective Scholarship Recipients for Islamic Senior High School Students application layout:

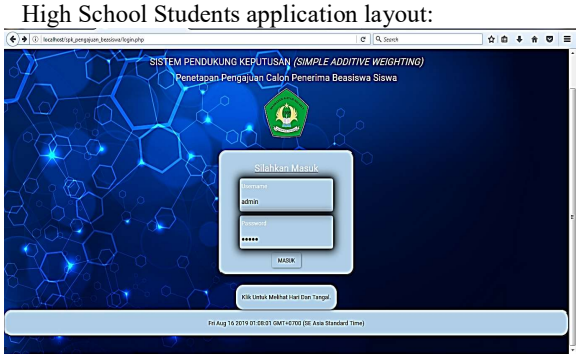

Figure 4. Login Menu

Figure 4. is the login menu, the menu that will appear for the first time when the user uses the application being developed. The user must enter the username and password data that was previously registered by the system administrator

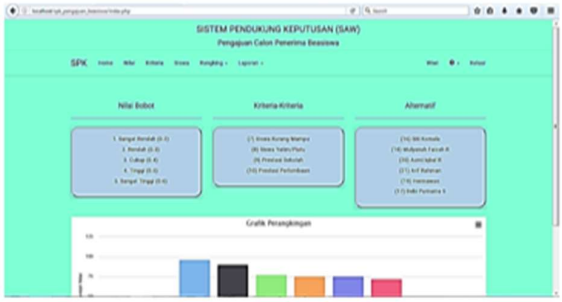

Figure 5. Main Menu

After the user can log in to the application, an initial menu will appear in the form of a dss application dashboard which was developed as shown in figure 5.

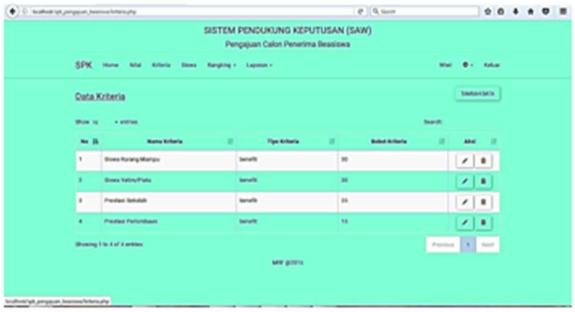

Figure 6. Criteria Menu

Users can enter criteria data that will be used as a reference in the calculation process in the DSS application developed as shown in figure 6

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Figure 7. Student Menu

Furthermore, the user can enter the names of students who are proposed to receive scholarships as shown in figure 7

Figure 8. Ranking Process

Then the user clicks the process button, and the system will perform calculations according to the criteria and input data entered by the user. then the system will display a list of prospective scholarship recipients based on the highest order as shown in figure 8.

Figure 9. Reporting

Users can display reporting produced by DSS applications developed as in figure 9 and users can also print these reports using a printer.

IV. CONCLUSION

DSS design research of determining the submission of prospective scholarship recipients for MAN students to the Ministry of Religion using the SAW method, it can be concluded as follows:

1. The DSS application made using the SAW method can help authorized officials at MAN 3 Tangerang in compiling a list of stipulations for proposing scholarship recipients from the Ministry of Religion.
2. With the application of the DSS with the determination of criteria and alternatives, the prospective scholarship recipient data is produced quickly, precisely and accurately, which is expected to make the process of determining scholarship candidates transparent and accountable.
3. The more alternatives (submission of prospective scholarship recipients) and the use of more specific criteria, the system will produce more accurate and accurate selection results

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Design Of Android Base School Information Media Application Case Study Of Qomariah Educational Institution

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Abstract - Currently the world of technology and information is developing very quickly, including school information systems. The school information system is one of the information media that can be accessed by all elements of the school including teachers and students so that they can relate to each other in terms of teaching and learning activities and information that can be quickly disseminated to all students, so that students do not need to come to school. in this technological era from young to old all use smartphones to facilitate communication but PKBM Qomariah does not yet have the right information media. So an Android-based school information system application was made using Android studio. Android applications make it easier for teachers and students because they can be accessed on various smartphones. All teachers and students mostly have smartphones. With this application, teachers and students can get information from schools easily. The research method used is descriptive method by conducting observations, literature studies, and interviews. While the method used in making software is waterfall which consists of several stages, namely requirements definition, system and software design, implementation and unit testing, system integration and testing, Operation and Maintenance.

Keywords - information system, android studio, smartphone, descriptive method, waterfall

I. INTRODUCTION

The development of information technology is currently developing in all fields, especially in the field of education. Many difficulties or problems can be facilitated or overcome by the role of information technology. Such as data storage, word processing, data processing, finance, information management, and so on. One of the developing technologies is Mobile Application. [7] Mobile Application is software that runs on mobile devices used for mobile services. [3] Where currently many people are users of an android application. [8] As the world of information and communication technology develops, android is increasingly recognized by many people, including in the world of education.[13] An educational institution will need information that is not only timely, but also correct and accurate information. [10] The need for information media dissemination facilities that are fast and easy is increasing, especially in android applications. [8] The Community Learning Activity Center (PKBM) is a place to complete non-formal schooling that does not pass formal education. This non-formal education is intended for students from disadvantaged communities, not in school, dropping out of school and dropping out of further education, as well as productive age who want to improve their knowledge and life skills. [6] PKBM qomariah is one of the community learning activity centers in bandung district. So far, the school has had a website but it is still less than optimal. [5] The lack of information is a contributing factor to the small number of learners.

Based on the above background, the author makes android-based school information media. Android is an operating system developed by Google and designed specifically for touchscreen devices such as smartphones and tablet computers. Android is open source which means it allows anyone to change the code and distribute the software under a license from Google. [1] Android is developed using the Java language with a Software Development Kit (SDK) that provides an effective and efficient Application Programming Interface (API). [2] Application Programming Interface (API) is an interface built by system developers so that some or all of the system's functions can be accessed programmatically. [11] APIs are also commonly thought of as a collection of clear techniques for creating communication between different software components. [11] System design using the *Unified*

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Modelling Languange (UML) is an industry standard language for specifying, visualizing, constructing, and documenting the artifacts of object-based software systems. [12] The test used is BlackBox testing is a software testing technique that focuses on the functional specifications of the software. [15] The blackbox testing method is one method that is easy to use because it only requires the lower limit and upper limit of the expected data.[9] The development stage used is waterfall. The waterfall model is the most frequently used software development model.[14] This development model is linear from the initial stage of system development, namely the planning stage to the final stage of system development, namely the maintenance stage. The next stage will not be implemented before the previous stage is completed and cannot return or repeat to the previous stage. [14] In this study, the authors started the data requirement stage through observation, design, implementation, integration, and operation. [4] The result of the research is an android-based school information media application.

II. RESEARCH METHODOLOGY

This study is about the application of school information media using the experiment method. This study has the aim of improving information media at PKBM Qomariah. The steps of this research are:

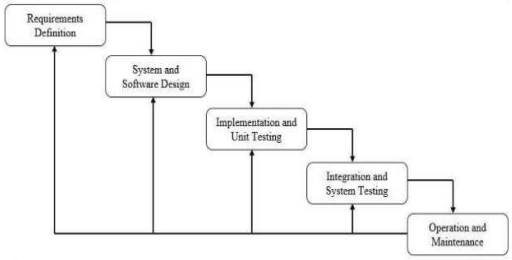

Figure 1. Research steps

A. Requirements Definition

At this stage, researchers communicate with PKBM Qomariah which aims to understand the limitations and expectations of the application to be made, information obtained using interviews, discussions and direct surveys. information is analyzed to obtain the required data.

B. System And Software Design

At this stage of application design, researchers design systems using the *Unified Modeling Languange* (UML) in the form of use case diagrams .

C. Implementation And Unit Testing

At this stage, researchers implement the source code and design of the Android programming language in designing the School Information Media application.

D. Intergration And System Testing

At this stage the researcher makes the application and coding, this application is tested which aims to find out whether the application from this system design is ready for use.

E. Operation And Maintenance

After this application is used and implemented, researchers perform regular maintenance in managing the application so that the application will continue to run according to its function.

III. RESULTS AND DISCUSSION

The result of this study include :

A. Requirements Definition

The current system is that students or visitors who want to get information must come to the school and communicate with PKBM Qomariah.

B. System And Software Design

In designing this application using use case diagrams and class diagrams.

Use case Application Diagram

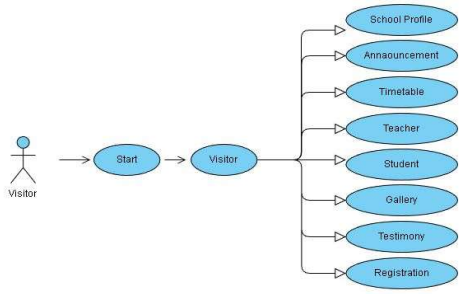

Figure 2. Use case diagram visitor

In this use case of actors using this application. visitors only need to select the selected target image and the android will display related information.

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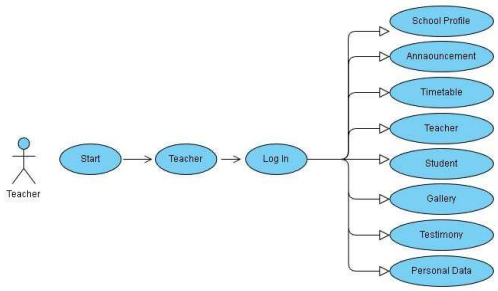

Figure 3. Use case diagram teacher

In the use case of actors using this application. teachers need to use an account to enter the application, after that they only need to select the selected target image and the android will display related information.

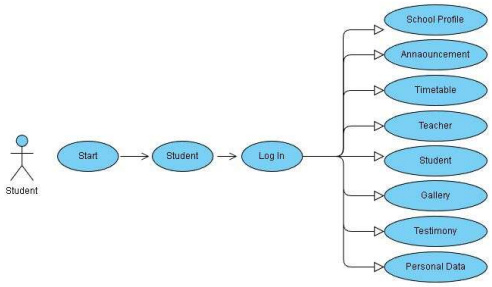

Figure 4. Use case diagram Student

In the use case of actors using this application. students need to use an account to enter the application, after that they only need to select the selected target image and the android will display related information.

C. Implementation And Unit Testing

This stage is the implementation of the system which is the result of the design in the form of an application.

Application View

1. Main menu

Figure 5. Main menu

Main menu view to select as visitor, student, or teacher.

2. Visitor menu

Figure 6. Visitor menu

View the visitor menu to select some of the available submenus.

3. Login menu

Figure 7. Login menu

Login view for those who have access including teachers and students

4. Student menu

Figure 8. Student menu

View the student menu to select some of the available submenus.

5. Teacher menu

Figure 9. Teacher menu

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View the teacher menu to select some of the available submenus.

6. School profile

Figure 10. School profile

A page that displays the school profile.

Figure 11. Announcement

A page that displays existing announcements.

7. Timetable

Figure 12. Timetable

A page that displays the existing schedule.

8. Teacher data

Figure 13. Teacher data

A page that displays a list of registered teachers.

9. Student data

Figure 14. Student data

A page that displays a list of registered students.

10. Gallery

Figure 15. Gallery

A page that displays a gellery of school activities.

11. Testimony

Figure 16. Testimony

A page that displays testimonials who have graduated from school.

12. Personal data

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Figure 17. Personal data

A page that displays personal data that has access.

13. Upload gallery

Figure 18. Upload gallery

A page to upload photos to the gallery available on the gallery submenu page on the teacher menu.

14. Add, update, delete Announcement

Figure 19. Add, update, delete Announcement

A pages to add, update, delete existing announcements.

15. Add, update, delete Timetable

Figure 20. Add, update, delete Timetable

A pages to add, update, delete existing timetable.

16. Add, update, delete Teacher data

Figure 21. Add, update, delete Teacher data

A pages to add, update, delete, registered teacher data.

17. Add, update, delete Student data

Figure 22. Add, update, delete Student data

A pages to add, update, delete, registered student data.

18. Add, update, delete Testimony

Figure 23. Add, update, delete Testimony

A pages to add, update, delete, existing testimonies.

D. Intergration And System Testing

At this stage the researcher conducts a trial which aims to determine whether the application of this system design is ready for use, among others, by distributing questionnaires to teacher and student respondents.

Table 1. Visitor page testing

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No	***Category***	***Test name***	***Results***
1	Main menu	Main menu display	Fine
2	Visitor menu	Visitor menu display	Fine
3	School profile sub menu	School profile display	Fine
4	Announcement sub menu	See announcement list	Fine
5	Timetable sub menu	See timetable list	Fine
6	Teacher data sub menu	See Teacher name	Fine
7	Student data	See students name	Fine
8	Gallery	See gallery	Fine
9	Testimony	See Testimony list	Fine
10	Registration	See registration	Fine

Table 2. Student page testing

No	***Category***	***Test name***	***Results***
1	Main menu	Main menu display	Fine
2	Student menu	Student menu display	Fine
3	School profile sub menu	School profile display	Fine
4	Announcement sub menu	See announcement list	Fine
5	Timetable sub menu	See timetable list	Fine
6	Teacher data sub menu	See Teacher name	Fine
7	Student data	See students name	Fine
8	Gallery	See gallery	Fine
9	Testimony	See Testimony list	Fine

Table 3. Teacher page testing

No	***Category***	***Test name***	***Results***
1	Main menu	Main menu display	Fine
2	Teacher menu	Teacher menu display	Fine
3	School profile sub menu	School profile display	Fine
4	Announcement sub menu	See announcement list	Fine
5	Add announcement	Add announcement	Fine
6	Update announcement	Update announcement	Fine
7	Delete announcement	Delete announcement	Fine
8	Timetable sub menu	See timetable list	Fine
9	Add timetable	Add timetable	Fine
10	Update timetable	Update timetable	Fine
11	Delete timetable	Delete timetable	Fine
12	Teacher data sub menu	See Teacher name	Fine
13	Add teacher	Add teacher	Fine
14	Update teacher	Update teacher	Fine
15	Delete teacher	Delete teacher	Fine
16	Student data sub menu	See students name	Fine
17	Add student	Add student	Fine
18	Update student	Update student	Fine
19	Delete student	Delete student	Fine
20	Gallery sub menu	See gallery	Fine
21	Upload photos for gallery	Upload a photo	Fine
22	Testimony sub menu	See Testimony list	Fine
23	Add testimony	Add testimony	Fine
24	Update testimony	Update testimony	Fine
24	Delete testimony	Delete testimony	Fine

So it can be concluded based on the results respondents through the assessment of this application is very good.

E. Operation And Maintenance

At this stage, researchers perform regular maintenance in managing the application so that the application continues to run according to its function and can be developed further. based on the table above This application is still in the development stage including correcting errors that were not found in the previous step and is expected to help, facilitate and improve school information services.

IV. CONCLUSION

based on the results of research conducted regarding Design Of Android Base School Information Media Application Case Study Of Qomariah Educational Institution it can be concluded that backbox testing shows that this application can run well.

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Dimensional Data Design for Event Feedback Data Warehouse

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Abstract **–** Data is an important asset and a fundamental requirement for building valuable information for organizations. Association of Information Systems Students of Unsika (Himsika) as a university organization provides many events to develop student's academic and professional skills. A post-event evaluation through a feedback survey was conducted and stored in Google Sheets spreadsheet format. However, the current analysis process using spreadsheets lacks standardization, making it difficult to compare satisfaction rates over time and between events. Additionally, the lack of standardization leads to semi-structured data on spreadsheets, with varying question formats and meanings. To address these limitations, implementing a centralized data warehouse is proposed as a solution. The data warehouse would provide a structured and standardized approach to analyzing event feedback, enabling better comparisons and evaluation of management quality within Himsika. The research aims to design a data warehouse that supports multidimensional analysis. As a way to simplify and optimize analytical queries, the data structure is standardized in the data warehouse. The Four-step Dimensional Design method is applied in designing dimensional modeling on the data warehouse, consisting of four stages including selecting the business process, declaring the grain, identifying the dimensions, and identifying the facts. The design process resulted in 4 dimensions of events, dim_instances, dim_degree_programs, and dim_professions, and a fact table called fact_rates_by_responses. Overall, the proposed data warehouse and dimensional modeling approach aim to enhance the analysis and evaluation of Himsika's events.

Keywords – Data Warehouse, Dimensional Data, Event Feedback, Four-step Dimensional Design, Himsika

I. INTRODUCTION

Data has become an important asset for an organization to build information. The collected historical data in massive amounts raises opportunities to perform analysis from many dimensions or known as multidimensional analysis (Agapito, Zucco, & Cannataro, 2020). Besides, data could be the driving aspect while making business decisions and understanding the current condition of the organization by extracting its value with data analysis (Dollah & Aris, 2018). The activity of data collection and analysis is not limited to profit organizations, but in the academic area as well (Yulianto, 2019).

The Association of Information Systems Students of Unsika or Himpunan Mahasiswa Sistem Informasi Unsika (Himsika) is one of the academic associations at the University of Singaperbangsa Karawang. As a student organization focusing on developing students' academic and professional skills, Himsika holds many events (Himsika, 2022). At the end of the events, they have to spread out a feedback survey of how satisfied the participants are with the event. The survey is used to evaluate the management quality of Himsika which should be reported at the end of their management period. In the as-is process, the collected feedback is analyzed by screening the raw data in the form of spreadsheets. There are limitations to comparing the satisfaction rate by time as well as comparing between events. Furthermore, in consequence of there being no standardization in Himsika, the survey tends to have different numbers, phrases, and meanings of questions, resulting in semi-structured data on the spreadsheet. In order to tackle the current problems, centralized data storage in the form of a data warehouse could be one of the solutions.

There are two primary methods proposed by Bill Inmon and Ralph Kimball for designing data warehouses, respectively (Haryono et al., 2020). The Inmon method employs a top-down approach within an enterprise scope, emphasizing highly normalized, consistent, and regulated data. On the other hand, the Kimball method adopts a bottom-up approach in the business area, allowing frequent data redundancy and revisions. In terms of development time, the Inmon method typically requires a longer initial design and implementation time compared to the Kimball method (Wijaya, 2022). When it comes to data modeling, there are four stages in the Kimball method encompasses four stages known as the Four-step Dimensional Design method (Iswari, Fudholi, & Aditya, 2019).

Various studies have employed the Four-step Dimensional Design method to model data in the data warehouse. In the context of higher education, Togatorop (2018) explained how dimensional data design supports the analysis of new-year undergraduate students at a university. The research utilized a star schema that included 4 fact tables, the fact of registration, selection, registrant per school, and school alumni. The dimensional tables comprised 10 dimension tables that facilitated multidimensional analysis. Several dimensions, such as date, registrant, period, high school, and study program, were shared among the fact tables.

Another study conducted by Lapura, Fernandez, Pagatpat, & Dinawanao (2018) discussed the utilization of Kimball Modeling Techniques for building a data warehouse, which follows the same steps as the Four-step Dimensional Design method. The research focused on selecting the business process, specifically examining aggregated financial amounts across dimensions such as funds, categories, and clusters. The data model was designed with a granularity level that ensured each data point represented the allocation, expenditure, and balance for a specific fund on a given day. Dimension tables were created to incorporate dimensions of funds, finance units, accounts, and time, while the fact tables accommodated various measurements, including allocation, balance, obligation, and transferred funds.

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Similarly, Yulianto (2019) utilized the Four-step Dimensional Design approach to structure and model data within a data warehouse, intending to employ it as the storage destination for an Extract-Transform-Load (ETL) pipeline. The resulting fact table included data related to new students, registrations, grades, graduation, and payments. Furthermore, the generated dimension tables comprised the time dimension, program of study dimension, and school dimension. This research demonstrates the integration of the Four-step Dimensional Design method as an effective data modeling technique in developing a data warehouse infrastructure.

Another data modeling method that can be utilized is the Nine Steps Methodology, which also covers the data warehouse implementation stages. The first four stages of this methodology align with the Four-step Dimensional Design method, which is employed for modeling dimensional data. Rahutomo, Putri, & Pardamean (2019) presented the additional stages used for implementing the data model and loading data into the data warehouse. These stages encompass storing pre-calculation in the fact table, tracking changes in dimensions with gradual change, and determining priorities and query modes. The research output is a data warehouse containing multiple storage units of historical data from various periods, enabling the analysis of trends.

In a study conducted by Al-Faris, Suharjito, Diana, and Nugroho (2018), the Nine Steps Methodology was applied in developing a data warehouse for an information technology services company. The methodology resulted in a physical data warehouse model comprising 8 fact tables and 9 dimension tables. The data warehouse employed an Extract-Transform-Load (ETL) process to load data from diverse sources. As a result, the company was able to track service requests requiring follow-up and predict sales performance.

This research aims to design a dimensional data model for the event feedback of Himsika. The data model supports the multidimensional analysis on a centralized and clear-structured data warehouse. As to focus on the data modeling aspect, the approach used in the research is the Four-step Dimensional Design method.

II. RESEARCH METHODOLOGY

A. Literature Review

The theoretical foundation used in this research includes data warehouse and data modeling. The research follows the Four-step Dimensional Design Kimball methodology to design the dimensional data model.

1. Data Warehouse

In "Data Engineering with Google Cloud Platform," a data warehouse is defined as a technology that transforms data from an operational system into another system used to support decision-making. The main principles of a data warehouse are to combine data from multiple sources in a centralized location and transform it into an analytically accessible and processable format. Data in a data warehouse can be analyzed through machine learning modeling, data visualization, and report generation (Wijaya, 2022). A data warehouse is also referred to as an online analytical processing (OLAP) database due to its analytical nature (Garani & Butakova, 2019).

A data warehouse has characteristics that allow data to be organized in a subject-oriented manner. This means that data can be analyzed based on specific business subjects. The collected data tends to be non-volatile, resulting in a large amount of historical data. This historical data is identified by the period of its collection time, also known as 'time-variant'.

The other characteristic of a data warehouse is the data modeling schema used. While transactional databases model the data relationally (Yaqub, Kamel, & Aung, 2020), data warehouse uses a dimensional approach (Wijaya, 2022). Through this kind of modeling, data can be analyzed in general (roll-up) or in a more detailed view (drill-down). The analysis is also able to be focused on some data points of a dimension (slice) as well as multiple data points between dimensions (Challal et al., 2019). Dimensional data modeling in data warehouses can optimize data read operation as it is mainly used in the analytical activity (Wijaya, 2022).

2. Data Modeling

Data modeling is a process to represent database objects in the real world or business perspective. In a data warehouse, data modeling has to be representative of the real world because the end-users of a data warehouse are people and not a computer program. Data modeling is also used to ensure data consistency, optimize query performance, and increase efficiency in storage. One of the methods to model data in a data warehouse is the Kimball method (Wijaya, 2022).

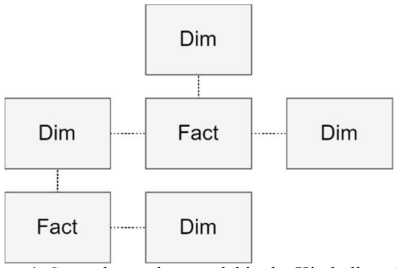

Figure 1. Star schema data model in the Kimball method

The Kimball method takes a bottom-up approach that focuses on answering business questions of a specific domain. The method resulted in several tables called 'fact' and 'dimension' (Turcan & Peker, 2022). The dimension table represents an entity along with its attributes. In the Kimball method, dimension tables are designed to be denormalized consequent in data redundancy. On the other hand, a fact table is a measurement table that has a certain level of granularity. The fact table is located in the center and is surrounded by dimension tables that determine its level of granularity (Wijaya, 2022). This design of fact and dimension tables is called a star schema (Garani & Butakova, 2019).

3. Four-step Dimensional Design Method

The Four-Step Dimensional Design Method is a method for designing a multidimensional data model in a data warehouse. This method emphasizes a bottom-up approach

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where data is stored based on business needs. The resulting modeling will form a schema called a star schema. The Four-Step Dimensional Design Method consists of four stages as follows (Lapura et al., 2018):

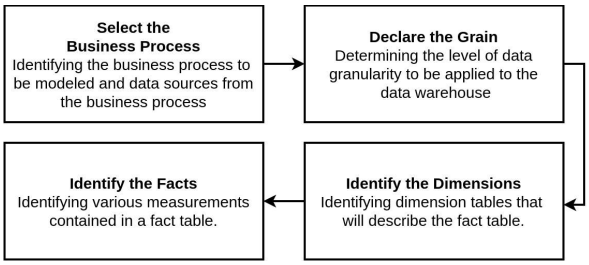

Figure 2. Four-step Dimensional Design method

a. Select the Business Process

This stage determines the operational activities that will be measured for performance. The selection of business processes will determine the output of the next stage. Some examples of business processes include financial activities (Lapura et al., 2018) and academic processes conducted by educational institutions. The selection of business processes is carried out by considering analysis needs and data availability (Yulianto, 2019).

b. Declare the Grain

Granularity is the level of detail in the data analyzed in a data warehouse. Granularity sets limits on what can be represented by a fact table. Each declared granularity will be implemented separately into a fact table. Through the declaration of granularities, the detailed information held by the data in the fact table is determined (Vincentdo, Pratama, Girsang, Suwandi, & Andrean, 2019). Additionally, the declaration of granularities also sets the candidate fact tables to be built (Fardhani, 2018).

c. Identify the Dimensions

This stage identifies entities and their attributes that are used to describe measurements in the fact table. Entities are represented in dimension tables to support the filtering and grouping of facts (Lapura et al., 2018). The identified dimensions are obtained based on the subject of the business process (Turcan & Peker, 2022). Dimension tables are commonly created in a data warehouse including time and date dimensions (Yulianto, 2019).

d. Identify the Facts

This stage identifies the measurements that exist in the fact table (Lapura et al., 2018). Measurements are obtained from the business process carried out by the organization. Each fact table implements a declared granularity that has been declared in the initial stage. A fact table is designed to be consistent with the granularity. This consistency ensures that analysis can be performed accurately (Yulianto, 2019).

B. Methodology

The complete stages of the research process are shown in the below image.

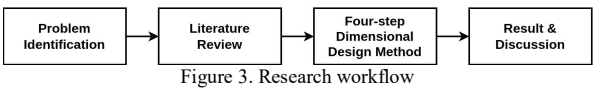

Figure 3. Research workflow

1. Select the Business Process

In this research, the business process being measured is the event feedback of Himsika. The process produces event feedback data in multiple spreadsheets. This data is used as the data source of the dimensional model data warehouse.

2. Declare the Grain

This research identified one candidate of the fact table, which is the fact of participant satisfaction. The granularity in the fact table is in the level of feedback responses.

3. Identify the Dimensions

Based on the selected business process and data availability, there are several dimensions identified. These dimensions are the event dimension and participant profile dimensions, such as instances, study programs, and professions.

4. Identify the Facts

The fact table in this research at least includes a table called the fact of participant satisfaction. The table provides data analysis measurements, such as the total number of participants and the percentages of participant satisfaction rate with the speaker, committee/management, and the overall event.

III. RESULTS AND DISCUSSION

The Four-step Dimensional Design method is used to model the dimensional data. The results of each stage of the method are described as follows.

A. Select the Business Process

The selected business process is the event feedback from events held by the Association of Information Systems Students of Unsika or Himpunan Mahasiswa Sistem Informasi Unsika (Himsika). The data sources come from 11 events held from 2020/2021 to 2021/2022. The data is available in a spreadsheet format of Google Sheets and has various structures, called semi-structured data. As a way to simplify and optimize analytical queries, the data structure is standardized in the data warehouse. The below table shows 11 events used as the data source.

Table 1. Event feedback data description

Events	Held Year	Feedback
Pameran Expopedia	2021	4
Seminar Bisnis	2021	241
Talkshow Let's PKM	2021	9
Webinar Expopedia	2021	63
Webinar Online Career Talk (Oncat)	2021	130
Workshop *Program Belajar Bareng* (PBB)	2021	191
Talkshow Silogy Fest a. *Peserta* Online b. *Peserta* Offline	2022	 14 15
Webinar Marathon *Acara* 1	2022	80
Webinar Marathon *Acara* 2	2022	58
Workshop PBB UI/UX	2022	69
Workshop PBB Python	2022	71
Total Feedback		945

B. Declare the Grain

Based on the selected business process and data

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availability, a candidate fact table is determined, namely the fact of participant satisfaction. The granularity level in the candidate table is at the level of the event participant's response. This granularity declaration ensures that the fact table accurately represents the business process and provides meaningful information.

C. Identify the Dimensions

Dimension identification is based on the availability of data that can describe each measurement in the fact table. The following table contains 4 dimensions generated at this stage. The four dimensions are selected because they have categorical data sources. In terms of multidimensional analysis, the event dimension is employed to filter specific event data and measure the success rate of the event. Analysis of the participant's originating institution can be conducted through the institution dimension. The institution dimension can also be utilized to determine the number of participants from partner institutions with Himsika. Analysis through this dimension can be used to assess the success of Himsika's partnerships with organizations in other institutions. Through the study program dimension, analysts can observe the variation in the study programs of student participants. Meanwhile, the profession dimension allows for an analysis of event accessibility in terms of participants' occupational backgrounds, such as employees, lecturers or teachers, students, high school students, and the general public. Analysis of the study program and profession dimensions can also serve as a basis for how common the event is, whether it is focused on a particular domain or more broadly inclusive of diverse participants.

Table 2. Dimension table design

Dimensions	Attributes	Description
Event	Unique Identity	Unique identity of the event
	Event Name	Event name
	Organizing Cabinet	Name of organizing cabinet
	Held At	Event hold date
	Last Feedback Response	Last response date in the feedback survey
Institution	Unique Identity	Unique identity of the institution
	Institution	Name of participant's institution
Study Program	Unique Identity	Unique identity of the study program
	Study Program	Name of participants study program
Profession	Unique Identity	Unique identity of the profession
	Profession	Name of participant's profession

D. Identify the Facts

The identified fact table candidate is a single candidate, namely participant satisfaction with granularity in each response. Thus, the candidate selected as the fact table is the fact of participant satisfaction rate by responses. The measurements designed in the fact table consist of assessments of several aspects of the event, such as speakers, management, and overall event satisfaction. The following table details the design of analysis measurements in the fact table.

Table 3. Fact table design

Fact	Measurements	Description
Participant satisfaction rate by responses	Timestamp	The time of filling out the feedback survey
	Comment	Participant's comments in the form of suggestions or criticism
	Study Year	The academic year of the participant
	Revisit Expectation	Participant's statement of interest to attend future events
	Speakers Rate	Average rating of the speaker assessment
	Management Rate	Average rating of the management assessment
	Overall Event Rate	Average rating of the overall event
	Duration Rate	Average rating of the duration of the event
	Topic Rate	Average rating of the topic of the event
	MC Rate	Average rating of the host or master of ceremony (MC)
	Moderator Rate	Average rating of the event moderator

IV. CONCLUSION

The design result demonstrates the successful creation of a dimensional data model for the event feedback of Himsika. The semi-structured event feedback is now standardized and centralized within the data warehouse. The dimensional model enables analysis of participant satisfaction rates from multiple dimensions, including events, instances, study programs, and professions. The measurements provide insights into the satisfaction levels related to speakers, event management, and the overall event experience.

In the development of this research, a physical data warehouse can be implemented. The Extract-Transform-Load (ETL) process can be employed to load data from various semi-structured spreadsheets in Google Sheets into the data warehouse. Additionally, a presentation layer can be created to visualize the data in the data warehouse more interactively.

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Global Horizontal Irradiance Prediction using the Algorithm of Moving Average and Exponential Smoothing

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Abstract – To reduce the discrepancy between the results of the expected data and the actual data, prediction is a procedure that is calculated systematically based on owned historical and present information. For the creation of solar energy projects and for decision-making in other connected domains, solar radiation intensity prediction is essential. This study aims to create a predictive model on monthly global horizontal irradiance data. The method used is the Simple Moving Average algorithm, Exponentially Weighted Moving Average and Single Exponential Smoothing. The stages carried out in this study include data collection, data preprocessing, testing of predictive models, interpretation of data visualization, and performance evaluation. The results of calculating the error value and correlation produce an evaluation of the performance of the prediction model. The SES method, which obtained an MAE value of 7.13, a MAPE of 0.02%, an MSE of 88.07, an RMSE of 9.38, and an R^2 of 0.94, was determined to be the best prediction model by the calculation of the prediction model performance evaluation. A MAE value of 9.45, a MAPE of 0.02%, an MSE of 150.16, an RMSE of 12.25, and an R^2 of 0.91 were obtained by the EWMA method, which is also the method that produced the second-best result. A MAE value of 14.38, a MAPE of 0.04%, an MSE of 367.59, an RMSE of 19.17, and an R^2 of 0.77 were obtained by the SMA method, which is the third-best result.
Keywords – Prediction, Moving Average, Exponential Smoothing, Global Horizontal Irradiance

I. INTRODUCTION

Solar radiation is one of the most influential weather parameters in the climate system, where all weather and climate phenomena are initially caused by variations in the distribution of solar radiation reception. Fluctuations in the intensity of solar radiation received at the earth's surface form climate patterns on various time scales. In other hand, solar radiation patterns also provide important information in various sectors, such as agriculture, water resources, and energy [1]. It is important to make models and analyzes based on the availability of energy sources. It depends on the production of solar energy in a certain area to have a good design and analysis of solar energy [2]. Solar power is an unlimited source of energy because solar energy is the largest energy on Earth. For tropical countries like Indonesia, sunlight is very easy to find. Indonesia's average daily insolation ranges from 4.5 – 4.8 kWh/m2/day, so it has the potential to develop solar energy into a renewable energy source [3].

The value of the intensity of the sun changes throughout the year. The different graphical patterns of solar radiation intensity can also be caused by several factors, the distance from the sun to the earth which has changed from the previous year, the influence of gases, dust and water vapor which absorb sunlight and the length of time the sun rises and sets [4]. In order to see the pattern of radiation data in the future, an effective and efficient method is needed. One of them is by making a predictive model based on existing data from observations of the BMKG (Badan Meteorologi Klimatologi dan Geofisika) station as well as using several mathematical equations and data that has been published by previous solar radiation researchers [5]. Prediction of solar radiation intensity is a necessity for the establishment of solar energy projects and for decision making in other related fields [6]. Prediction is a process that is estimated systematically based on past and present information that is owned, so that the difference between the actual data and the results of the predicted data can be minimized. Predictions do not have to give a definite answer to what will happen, but try to find answers as close as possible to what will happen.

In order to have a good analysis of solar radiation data patterns in the future, in this paper we create a solar energy prediction model based on solar radiation data. This study discusses testing solar energy models using the Simple Moving Average (SMA), Exponentially Weighted Moving Average (EWMA), and Single Exponential Smoothing (SES) methods. The data collected from global horizontal irradiance (GHI) in instrument measurements at the Climatology Station Special Region of Yogyakarta. Global horizontal irradiation (GHI) measurements by ground-based are usually applied using pyranometers for solar energy and atmospheric applications [7]. This research used monthly average data for 5 years from 2018 – 2022 that shown in Figure 1.

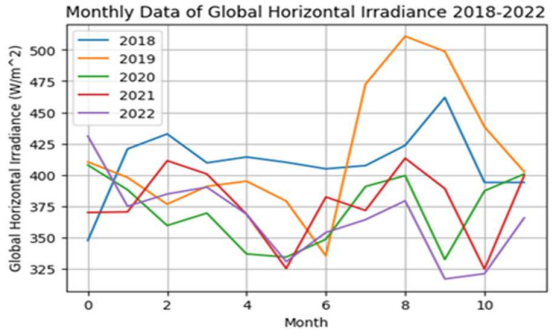

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Figure 1. Monthly Data of Global Horizontal Irradiance.

The prediction model consists of several methods, including Moving Averages and Exponential Smoothing. Moving Average is a method obtained by adding and finding the average value of the period, removing the oldest value every time and adding a new value [8]. Technical analysis is needed because it is easier to implement, requiring only historical GHI data. Moving Average is one part of the time series prediction method. The Moving Average method has two variants, the Simple Moving Average and the Weighted Moving Average. The difference between the two is in the weighting technique. Single Moving Average method that supports the calculation of time series data [9]. In the Exponentially Weighted Moving Average that a higher weight is given to the period closer to the predicted period [10]. Then, Exponential smoothing is a prediction method for recent observations. This prediction method focuses on deprioritizing older data, which means it pays more attention to the most recent observed values [8].

Previous research related to solar radiation data resulted in an evaluation of model performance in estimating the value of solar radiation intensity in the study area using two different modeling approaches, namely the empirical model by Keiser, Arkansas (AR) and the deterministic model. The three main weather variables used as model data input are rainfall (mm), maximum temperature (°C), and minimum temperature (°C). The results of testing have an R^2 value of 0.72 [11]. Similar research related to solar radiation data is to estimate the potential intensity of solar radiation as a renewable energy. The data used are solar radiation intensity data from Automatic Weather Station (AWS) from January 2012 to December 2015. Solar radiation intensity data were analyzed using non-linear regression methods, namely exponential methods, logarithmic methods, and power methods. The calculation results show that the exponential method gives a smaller error value than the other two methods. The error value on MAPE obtained ranges from 0.06% to 11.98% [12]. Those researches above has not yet arrived at a predictive model. Our research developed prediction model and modify the time series analysis method in predicting solar radiation data with only one parameter in order to further simplify computational performance. Then, the Coefficient of Determination (R^2) and Mean Absolute Percentage Error (MAPE) would be increased to the optimum work with the different model of Moving Average and Exponential Smoothing.

In another study, the prediction of motor vehicle test retribution data was carried out using the method Exponential Smoothing and Moving Average which aims to compare the effectiveness of the two methods in predicting motor vehicle testing fees. The measure of the effectiveness of the method is seen based on the MSE and MAPE values [8]. In our research shown prediction model in GHI data use single exponential smoothing and various model of Moving Average, there are Simple Moving Average and Exponentially Weighted Moving Average. Then those model would be evaluated with error and correlation value using Mean Absolute Error (MAE), Mean Absolute Percentage Error (MAPE), Mean Squared Error (MSE), Root Mean Squared Error (RMSE), and Coefficient of Determination (R^2) values.

Those model is implemented by Python to perform time series statistical data processing. As the final result, this study obtains a statistical model for predicting GHI compared to actual data with the lowest error value and the result have the good correlation between actual data and predicted data. It is hoped that this prediction model can be applied directly in predicting the availability of solar energy for planners of solar energy equipment and planners in fields including: climatology, hydrology, agriculture, and architecture.

II. RESEARCH METHODOLOGY

In the research methodology explained regarding the important steps carried out to carry out comparative methods in predicting GHI data, including data collection, data preprocessing, prediction model testing of dataset with SMA, EWMA, and SES by Python, interpreting the visualization of prediction model result, evaluating the performance of prediction models with MAE, MAPE, MSE, RMSE, and R^2. Finally, we have prediction models of time series data in Global Horizontal Irradiation. The flowchart of this research shown in Figure 2.

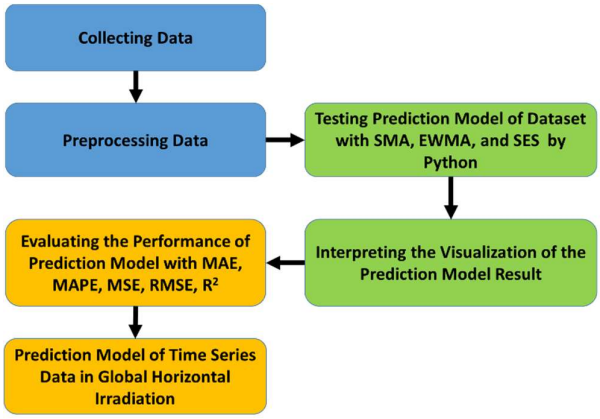

Figure 2. Flowchart of prediction model testing

After knowing the design work flow of this research, below will explain in more detail the processes involved in conducting data processing and data analysis on GHI predictions. Each process also explains the theoretical basis used to support the research ideas being carried out.

A. Collecting Data

The Automatic Solar Radiation System in Special Region of Yogyakarta, provided the pyranometer instrumentation for the ground measurements used to collect the GHI data, as illustrated in Figure 3.

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Figure 3. Measurement of GHI using a Pyranometer

The GHI data used are daily data recorded have ten minutes' interval from January 2018 to December 2022 at local time. This data can be processed to create a dataset that will be used to evaluate a time series prediction model.

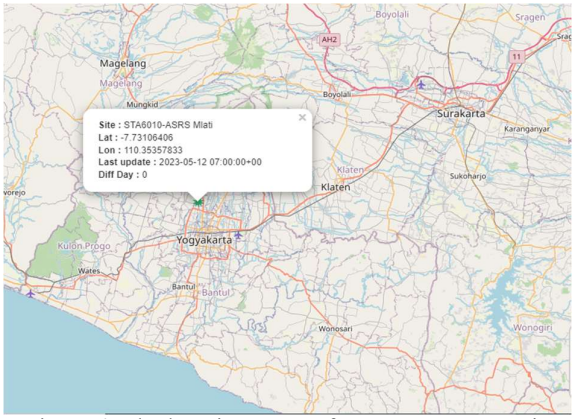

Figure 4. The location maps of GHI measurement in Climatology Station of Yogyakarta

Measurement GHI is product of Automatic Solar Radiation System (ASRS) that operated by Climatology Station Yogyakarta, Badan Meteorologi Klimatologi dan Geofisika (BMKG) located at Mlati, Sleman, Special Region of Yogyakarta. The location maps of this station shown in Figure 4.

B. Preprocessing Data

Preprocessing data is carried out quantitatively as data values in the form of counts or numbers where each dataset has a numerical value associated with data obtained from measurement sensors. This data is quantifiable information that can be used for mathematical calculations and statistical analysis.

Table 1. Raw Data of GHI Measurements

IDStation	Tanggal	Jam	GHI
STA6010	1/1/2019	11:00:00	739.3
STA6010	1/1/2019	11:10:00	483.4
STA6010	1/1/2019	11:20:00	464.6
STA6010	1/1/2019	11:30:00	397.3
STA6010	1/1/2019	11:40:00	751.8
STA6010	1/1/2019	11:50:00	1210.1
STA6010	1/1/2019	12:00:00	692.1

Table 1 depicts the unprocessed measuring equipment data, which included up to 4000 lines for each mount. The raw data is in local time, and we only use the values of the GHI parameters expressed in W/m^2. The next step is to filter the raw data, which must only include data from six in the morning to six in the evening. This time frame during which the GHI value could be obtained. Finally, the processing of daily data into monthly data was completed. The data output from preprocessing the data would be utilized as input for further calculations to choose the optimal prediction model.

Table 2. Monthly GHI Data 2018-2022

GHI	2018	2019	2020	2021	2022
January	347.64	410.40	407.93	370.00	431.06
February	420.80	398.03	388.17	370.49	374.98
March	432.79	376.63	359.59	411.39	384.77
April	409.70	390.90	369.52	400.80	390.22
May	414.34	395.03	336.87	368.70	368.70
June	410.12	379.18	334.35	325.25	330.71
July	404.90	335.35	348.53	382.38	354.03
August	407.49	472.53	390.79	371.64	364.28
September	423.65	510.87	399.49	413.40	379.37
October	461.95	498.74	332.44	389.10	316.87
November	394.04	438.44	387.30	324.75	321.11
December	394.04	402.64	400.73	399.48	365.67

Table 2 shows the results of the data preprocessing in the form of monthly GHI data. Monthly GHI data is obtained from 2018 to 2022. The time series data will be processed using Python for further analysis by visualization using data graphics and data statistical processing. Then using the SMA, EWMA, and SES methods to form the best predictive model.

C. Testing of Prediction Model

Testing using the SMA, EWMA and SES algorithms is a system development methodology after data preprocessing is carried out in analyzing data processing quantitatively. Quantitative data processing techniques use mathematical and statistical equations then are assisted by Python to calculate the algorithms of prediction model. The following are theoretical explanations of SMA, EWMA and SES.

Simple Moving Average (SMA) is the simplest moving average and does not use a value in predicting calculations. Although the SMA is quite effective in determining the current trend [13]. Despite its simplicity, SMA is very good in identifying the current trend [14]. This Equation (1) is the how to calculate the SMA.

$$Pred_{t+1} = \frac{Act_t + Act_{t-1} + \dots\ Act_{t-n+1}}{n} \quad (1)$$

$Pred_{t+1}$ is the prediction for period $t+1$. x_t is the data for period t. Act_t is the data real from observation for period t. Then, n is the period of moving averages. In the

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SMA this is calculated by taking the average value of the GHI data observation values at two month of span back.

Exponentially Weighted Moving Average (EWMA) is one approach to dealing with unstable data volatility. This method gives weight to changes in value each period using the decay factor (α). The parameter α shows the weight scale of the latest data observations with previous data with a value of $0 < \alpha < 1$. The higher the α value, the greater the weight that will be applied to past data so that the time series data is smoother [15]. To calculate EWMA, this formula shown in Equation 2.

$$y_t = \frac{\sum_{i=1}^{n} w_i * x_{t-i+1}}{\sum_{i=1}^{n} w_i} \quad (2)$$

y_t is the weighted moving average at time t. And x_t is the value at time t. w_i is the weight assigned to each value. n means the number of values used to calculate the moving average. This function is calculated using weights $w_i = (1-\alpha)^2$ would be the new formula in Equation (3).

$$y_t = \frac{x_t + (1-\alpha)x_{t-1} + (1-\alpha)^2 x_{t-2} + \ldots + (1-\alpha)^t x_0}{1 + (1-\alpha) + (1-\alpha)^2 + \ldots + (1-\alpha)^t} \quad (3)$$

The Single Exponential Smoothing (SES) method is used for short-term predictions. The model assumes that the data fluctuates around a fixed mean value, without a consistent trend or pattern of growth. The Single Exponential Smoothing method takes into account the weight of the previous data by giving weight to each data period to distinguish the priority of a data [16]. The formula for SES is as follows [17] in Equation (4).

$$Pred_{t+1} = \alpha * Act_t + (1-\alpha) * Pred_{t-1} \quad (4)$$

$Pred_{t+1}$ is a new prediction for period to $t+1$. Act_t describes the observation value of t period. α is a weight value indicating smoothing constant ($0 < \alpha < 1$). $Pred_{t-1}$ is a prediction for period $t-1$. Meanwhile, to calculate the alpha value (α) using the formula $\alpha = 2/(n+1)$. Where α is the weight value indicating smoothing constant ($0 < \alpha < 1$). Then, n is the number of time periods.

D. Interpreting of Visualization Data

Data interpretation is a stage carried out with the aim of associating the relationship between various research variables. In this study, the data was processed using a time series chart to find out the pattern of the data. After analyzing several prediction methods, the results are shown using a graph that displays the data prediction pattern of each method. This helps in identifying data patterns resulting in determining the best model.

E. Evaluating Performance.

The model of prediction need to evaluate with the values of MAE, MAPE, MSE, RMSE, and R^2. The evaluation with the error and correlation values describe about the effectiveness the model work for this data case. It is important to measure the best model needed. The following are theoretical explanations of MAE, MAPE, MSE, RMSE and R^2.

Mean Absolute Error (MAE) is one of the methods used to measure the accuracy of the prediction model. The MAE value shows the average absolute error between the prediction ($Pred$) results and the actual (Act) value. Then n is the number of periods used for calculations The MAE formula is explained as follows in Equation (5).

$$MAE = \frac{1}{n} \sum_{t=1}^{n} |Act_t - Pred_t| \quad (5)$$

Mean Absolute Percentage Error (MAPE) is a measure of the accuracy of $Prediction$ result compared to the $Actual$ result. This MAPE measurement is usually used to measure the accuracy of the predicted value of the time series. Result of MAPE measurements are generally in the form of a percentage. The smaller the percentage value generated by MAPE, the better the prediction results [18]. This formula shown in Equation (6).

$$MAPE = \frac{\sum_{t=1}^{n} \left| \left(\frac{Act_t - Pred_t}{Actual_t} \right) x10 \right|}{n} \quad (6)$$

Mean Square Error (MSE) is a calculation used to calculate the average power of errors in GHI data. From this equation it can be interpreted that $\sum_{t=1}^{n} (Act - Pred)^2$ is the result of subtraction between the actual and prediction values that have been squared, then the results are summed. And n is the number of periods used for calculations [19]. To calculate the MSE value, this Equation (7) shown below.

$$MSE = \frac{\sum_{t=1}^{n} (Act_t - Pred_t)^2}{n} \quad (7)$$

Root Mean Square Error (RMSE) is calculated by calculating the root of the sum of all the squared prediction errors divided by the number of prediction time data. The smaller the RMSE value, the more accurate the model is [20]. The RMSE determination was carried out to determine the best GHI prediction model. To calculate the RMSE value, the following Equation (8) shown below.

$$RMSE = \sqrt{\frac{\sum_{t=1}^{n} (Act - Pred)^2}{n}} \quad (8)$$

The coefficient of determination (R^2) is used to determine the proportion of the influence of all variables independent of the dependent variable [21]. The greater the R^2 of the independent variable, the more dominant the influence of the dependent variable is [22]. The formula of R^2 shown in Equation (9).

$$R^2 = 1 - \frac{\sum_{i=1}^{m} (Pred_i - Act_i)^2}{\sum_{i=1}^{m} (\overline{Act} - Act_i)^2} \quad (9)$$

$Pred_i$ is the prediction value to i , and the $Actual_i$ is the observation value to i. Then, $\overline{Act}$ is the mean of all observation data collected in dataset. The method predicts the Act_i for the corresponding $Pred_i$ of the dataset of GHI.

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III. RESULTS AND DISCUSSION

This part provides a comprehensive application and discussion of the research findings. Results are presented in tables, graphs, and figures. The analysis explained detail.

A. Testing of Prediction Model

The calculation of SMA using two span data executed by Python and convert to the table that consist of some attributes including period, GHI, and SMA. Table 3 shown the result of SMA calculation.

Table 3. Simple Moving Average Result

Period	GHI	SMA
2018-01-01	347.639895	NaN
2018-02-01	420.797452	384.218674
2018-03-01	432.787111	426.792282
2018-04-01	409.699329	421.243220
2018-05-01	414.344918	412.022123
2018-06-01	410.121655	412.233286
2018-07-01	404.904114	407.512885
2018-08-01	407.490266	406.197190
2018-09-01	423.651089	415.570677
2018-10-01	461.945614	442.798351
2018-11-01	394.039211	427.992413
2018-12-01	394.039211	394.039211
2019-01-01	410.402197	402.220704
2019-02-01	398.030920	404.216559
2019-03-01	376.634749	387.332834
2019-04-01	390.901592	383.768170
2019-05-01	395.028568	392.965080
2019-06-01	379.183653	387.106110
2019-07-01	335.354438	357.269046
2019-08-01	472.530611	403.942524
2019-09-01	510.872491	491.701551
2019-10-01	498.741799	504.807145
2019-11-01	438.436004	468.588902
2019-12-01	402.644495	420.540250
2020-01-01	407.930904	405.287700
2020-02-01	388.174581	398.052743
2020-03-01	359.593566	373.884073
2020-04-01	369.520977	364.557272
2020-05-01	336.874319	353.197648
2020-06-01	334.351108	335.612714
2020-07-01	348.525823	341.438466
2020-08-01	390.786970	369.656397
2020-09-01	399.492266	395.139618
2020-10-01	332.436617	365.964442
2020-11-01	387.296813	359.866715
2020-12-01	400.729336	394.013075
2021-01-01	370.003121	385.366229
2021-02-01	370.491812	370.247466
2021-03-01	411.388600	390.940206
2021-04-01	400.798169	406.093384
2021-05-01	368.697186	384.747678
2021-06-01	325.250182	346.973684
2021-07-01	382.384502	353.817342
2021-08-01	371.635482	377.009992
2021-09-01	413.398784	392.517133
2021-10-01	389.095656	401.247220
2021-11-01	324.754933	356.925295
2021-12-01	399.483070	362.119001
2022-01-01	431.063684	415.273377
2022-02-01	374.975540	403.019612
2022-03-01	384.766990	379.871265
2022-04-01	390.218336	387.492663
2022-05-01	368.697186	379.457761
2022-06-01	330.708146	349.702666
2022-07-01	354.025390	342.366768
2022-08-01	364.279495	359.152443
2022-09-01	379.365520	371.822508
2022-10-01	316.873755	348.119638
2022-11-01	321.114181	318.993968
2022-12-01	365.668471	343.391326

Calculation Data in The calculation of EWMA using two span data executed by Python and convert to the table that consist of some attributes including period, GHI, and EWMA. Table 4 shown the result of EWMA calculation.

Table 4. Exponentially Weighted Moving Average Result

Period	GHI	EWMA
2018-01-01	347.639895	347.639895
2018-02-01	420.797452	402.508063
2018-03-01	432.787111	423.470481
2018-04-01	409.699329	414.174953
2018-05-01	414.344918	414.288731
2018-06-01	410.121655	411.506865
2018-07-01	404.904114	407.103017
2018-08-01	407.490266	407.361222
2018-09-01	423.651089	418.221685
2018-10-01	461.945614	447.371465
2018-11-01	394.039211	411.816428
2018-12-01	394.039211	399.964928
2019-01-01	410.402197	406.923112
2019-02-01	398.030920	400.994983
2019-03-01	376.634749	384.754826
2019-04-01	390.901592	388.852670
2019-05-01	395.028568	392.969935
2019-06-01	379.183653	383.779080
2019-07-01	335.354438	351.495985
2019-08-01	472.530611	432.185736
2019-09-01	510.872491	484.643573
2019-10-01	498.741799	494.042390
2019-11-01	438.436004	456.971466
2019-12-01	402.644495	420.753485
2020-01-01	407.930904	412.205098
2020-02-01	388.174581	396.184753
2020-03-01	359.593566	371.790628
2020-04-01	369.520977	370.277527
2020-05-01	336.874319	348.008722
2020-06-01	334.351108	338.903646
2020-07-01	348.525823	345.318431
2020-08-01	390.786970	375.630790
2020-09-01	399.492266	391.538441
2020-10-01	332.436617	352.137225
2020-11-01	387.296813	375.576950
2020-12-01	400.729336	392.345207
2021-01-01	370.003121	377.450483
2021-02-01	370.491812	372.811369
2021-03-01	411.388600	398.529523
2021-04-01	400.798169	400.041954
2021-05-01	368.697186	379.145442
2021-06-01	325.250182	343.215269
2021-07-01	382.384502	369.328091
2021-08-01	371.635482	370.866352
2021-09-01	413.398784	399.221307
2021-10-01	389.095656	392.470873
2021-11-01	324.754933	347.326913
2021-12-01	399.483070	382.097684
2022-01-01	431.063684	414.741684
2022-02-01	374.975540	388.230921
2022-03-01	384.766990	385.921634
2022-04-01	390.218336	388.786102
2022-05-01	368.697186	375.393491
2022-06-01	330.708146	345.603261
2022-07-01	354.025390	351.218014
2022-08-01	364.279495	359.925668
2022-09-01	379.365520	372.885569
2022-10-01	316.873755	335.544360
2022-11-01	321.114181	325.924241
2022-12-01	365.668471	352.420394

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The calculation of SES using two span data and 0.75 alpha value executed by Python and convert to the table that consist of some attributes including period, GHI, and SES. Table 5 shown the result of SMA calculation.

Table 5 Single Exponential Smoothing Result

Period	GHI	SES
2018-01-01	347.639895	347.639895
2018-02-01	420.797452	402.508063
2018-03-01	432.787111	425.217349
2018-04-01	409.699329	413.578834
2018-05-01	414.344918	414.153397
2018-06-01	410.121655	411.129591
2018-07-01	404.904114	406.460483
2018-08-01	407.490266	407.232820
2018-09-01	423.651089	419.546522
2018-10-01	461.945614	451.345841
2018-11-01	394.039211	408.365868
2018-12-01	394.039211	397.620875
2019-01-01	410.402197	407.206867
2019-02-01	398.030920	400.324907
2019-03-01	376.634749	382.557288
2019-04-01	390.901592	388.815516
2019-05-01	395.028568	393.475305
2019-06-01	379.183653	382.756566
2019-07-01	335.354438	347.204970
2019-08-01	472.530611	441.199201
2019-09-01	510.872491	493.454168
2019-10-01	498.741799	497.419891
2019-11-01	438.436004	453.181976
2019-12-01	402.644495	415.278865
2020-01-01	407.930904	409.767894
2020-02-01	388.174581	393.572909
2020-03-01	359.593566	368.088402
2020-04-01	369.520977	369.162833
2020-05-01	336.874319	344.946448
2020-06-01	334.351108	336.999943
2020-07-01	348.525823	345.644353
2020-08-01	390.786970	379.501316
2020-09-01	399.492266	394.494528
2020-10-01	332.436617	347.951095
2020-11-01	387.296813	377.460383
2020-12-01	400.729336	394.912098
2021-01-01	370.003121	376.230365
2021-02-01	370.491812	371.926450
2021-03-01	411.388600	401.523063
2021-04-01	400.798169	400.979392
2021-05-01	368.697186	376.767738
2021-06-01	325.250182	338.129571
2021-07-01	382.384502	371.320769
2021-08-01	371.635482	371.556804
2021-09-01	413.398784	402.938289
2021-10-01	389.095656	392.556314
2021-11-01	324.754933	341.705278
2021-12-01	399.483070	385.038622
2022-01-01	431.063684	419.557419
2022-02-01	374.975540	386.121010
2022-03-01	384.766990	385.105495
2022-04-01	390.218336	388.940126
2022-05-01	368.697186	373.757921
2022-06-01	330.708146	341.470590
2022-07-01	354.025390	350.886690
2022-08-01	364.279495	360.931294
2022-09-01	379.365520	374.756963
2022-10-01	316.873755	331.344557
2022-11-01	321.114181	323.671775
2022-12-01	365.668471	NaN

B. Interpreting of Visualization Data

Data visualization on GHI time series data can be done periodically. Figure 5 shown the graphical pattern of GHI data from 2018-2022.

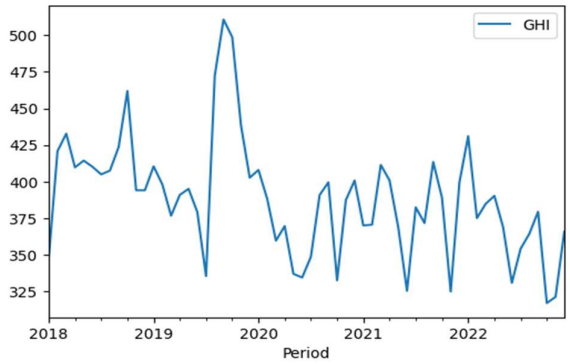

Figure 5. The Graphical Pattern of GHI Data 2018-2022

Patterns can be observed visually where the data is lowest and highest. Furthermore, the range of values can be observed through the graph.

The results of SMA, EWMA, and SES calculations are visualized in graphs. The graph can explain the comparison between the SMA, EWMA, and SES prediction models visually and makes it easier to see the pattern of predictions made. Figure 6 shows a comparison graph of the SMA, EWMA, and SES prediction models.

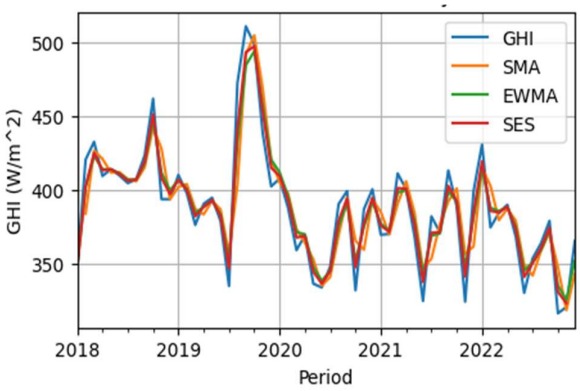

Figure 6. Comparison of SMA, EWMA, and SES Model

From the comparison of models based on graphs, it will be explained in more detail in the next section related to the evaluation values in the form of errors and the correlation of each prediction model with actual observation data.

C. Evaluating Performance.

In this study, evaluation of error values was used in the form of MAE, MAPE, MSE, RMSE, and evaluation of correlation values using R2. The Table 6 shows the results of a comparison of the performance evaluation of the SMA, EWMA, and SES prediction models.

Table 6. Comparison the Evaluation of SMA, EWMA, and SES Model

METHODS	MAE	MAPE	MSE	RMSE	R^2
SMA	14.38	0.04%	367.59	19.17	0.77
EWMA	9.45	0.02%	150.16	12.25	0.91
SES	7.13	0.02%	88.07	9.38	0.94

D. Prediction Model of GHI

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Application of the SMA algorithm. EWMA and SES are comparative analysis of performance tests on predicted solar radiation (GHI) data. The test results show that SMA, EWMA and SES have evaluation values in the form of error and correlation values. The range of each value can be considered to make decisions with the best model of prediction. The tested models could improve the methods of previous research in estimation of solar radiation with some other parameters that result of testing has an R^2 value of 0.72. In our research used only single parameter to support the more effective computation and our research produced better correlation values for prediction obtained 0.77 in SMA, 0.91 in EWMA, and 0.94 in SES. Then, our research also could improve the MAPE value in other previous research about estimate the potential intensity of solar radiation as a renewable energy. The error value on MAPE obtained ranges from 0.06% to 11.98%. In our research could modify the data solar radiation (GHI) into time series prediction model that produced the better MAPE value obtained 0.04% in SMA, 0.02% in EWMA, and 0.02% in SES. Based on the evaluation of model prediction, the SES model could work better than EWMA and also EWMA could work better than SMA in GHI prediction data.

IV. CONCLUSION

The results of this study indicate a comparative analysis of the performance levels of the SMA, EWMA, and SES methods in predicting GHI data. Evaluation of the GHI data prediction method can be carried out based on the calculation of error values and correlations in MAE, MAPE, MSE, RMSE, and R2. The results of the calculation of the prediction model performance evaluation produced the best prediction model is the SES method that obtained an MAE value of 7.13, a MAPE of 0.02%, an MSE of 88.07, an RMSE of 9.38, and an R2 of 0.94. The second best result is the EWMA method that obtained an MAE value of 9.45, a MAPE of 0.02%, an MSE of 150.16, an RMSE of 12.25, and an R2 of 0.91. The third best result is the SMA method that obtained an MAE value of 14.38, a MAPE of 0.04%, an MSE of 367.59, an RMSE of 19.17, and an R2 of 0.77. In this study using data and methods that are still limited, therefore suggestions for further research can use a more diverse method and increase the amount of data to improve higher predictive performance.

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Decision Support System for Selecting Rescuer Candidates for Basarnas Special Group Using SMART And BORDA

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Abstract *– The National Search and Rescue Agency (also known as BASARNAS) is a government agency responsible for offering search and rescue services in the event of an accident or disaster. At BASARNAS there is a special team, the BASARNAS Special Group (BSG). BSG performs rescues during national and international disasters or accidents. BSG itself consists of selected people, namely BSG candidates from all search and rescue office rescuers in Indonesia. BSG candidates themselves are still calculated manually so that it can affect the time efficiency of SAR personnel in making selections, this research was conducted at the Medan Class A Search and Rescue Office. To ensure that BSG candidates are accurate and processed quickly, a decision support system is needed. This time the researchers utilized the Simple Multi Attribute Rating Technique (SMART) and BORDA methods to determine BSG candidates. With the criteria used, namely fitness (K1), physical health (K2), mental health (K3) and creativity (K4). Then the alternatives used are 25 alternatives which include 20 skilled rescuers and 5 beginner rescuers. and the results can be saved in the form of a PDF file. The results of calculations using the SMART and BORDA methods found that among skilled rescuers, Rescuer-T15 is a suitable candidate to become a BSG candidate by obtaining a total score of 6049.25 and among novice rescuers, Rescuer-P5 obtained the highest score of 756.00.*

Keywords – DSS, Rescuer, BSG, SMART, BORDA

I. INTRODUCTION

Human safety is the top priority in every rescue operation carried out by the Badan SAR Nasional on land, sea and air. This is because human safety is the most fundamental human value and is the ultimate goal of every SAR action. The concept of SAR encompasses various tasks involving the search, assistance, and rescue of individuals who are at high risk due to circumstances like being misplaced or in peril during events such as aviation incidents, maritime accidents, or natural calamities. Badan SAR Nasional or BASARNAS is a non-ministerial government agency responsible for providing SAR or Search and Rescue services in disaster or accident situations[1]. Medan Class A Search and Rescue Office is one of the organizations in the formal environment of the government apparatus and is responsible to the Head of the BASARNAS. This office makes a considerable contribution to the search and rescue of missing people and materials in the province of North Sumatra[2].

Rescuers are officers responsible for rescuing and helping disaster victims in various terrains, including land, sea and air. Rescuers are specially trained and skilled in rescue techniques and strategies, and are equipped with adequate equipment and tools to deal with different disaster situations. They also have the ability to communicate with various related parties in order to coordinate and handle disasters effectively[3].

At the Badan SAR Nasional there are *Basarnas Special Group* (BSG) personnel, BSG itself consists of BASARNAS rescuer personnel selected from all over Indonesia. BSG refers to a distinguished group within BASARNAS that possesses exceptional expertise in a range of specialized areas, including *Medical First Responder* (MFR), *High Angle Rescue Technique* (HART), *Jungle Rescue*, *Water Rescue*, *Heli Rescue*, *Collapsed Structure Search and Rescue* (CSSR), as well as Parachuting. The selection process for BSG Candidate Rescuers relies on multiple criteria, which are currently assessed and documented manually. However, this manual approach often leads to inaccurate calculations, resulting in the inconsistent determination of all rescuers, including both experienced and novice individuals. To get rescuers who are suitable to be BSG candidates with consistent, accurate calculations, and processed through computing speed and can emphasize statements about the quality of rescuers who are candidates, it is necessary to have a decision support system that can determine rescuers.

To resolve the problems above, it is necessary to build a *Decision Support System* (DSS), DSS is a system used to assist decision making by collecting, analyzing, and processing information to produce the best alternative decisions[4]. In this study, the SMART (*Simple Multi Attribute Rating Technique*) and BORDA methods will be applied. To determine the ranking of rescuer selection decisions. Some previous studies that are relevant research objects such as [5] Decision Support System for Selection of the Best Members of the Fire Department Using the *Analitycal Hierarchy Process* (AHP) Method and [6] *Analitycal Hierarchy Process* and BORDA Methods for Selection of School Operational Exemption Recipients.

This research aims to accelerate and improve the effectiveness and efficiency in selecting the right rescuer to be a BSG candidate at the center. In addition, this research also aims to provide solutions to problems that often arise in the rescuer selection process, such as subjectivity in decision making. By using the SMART and BORDA

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methods, it is hoped that an objective decision support system can be created and can help make more accurate and precise decisions in selecting BSG candidate rescuers at the Search and Rescue Office.

A. Decision Support System

In essence, the Decision Support System (DSS) is specifically developed to aid every step of the decision-making process. This includes tasks such as problem definition, selection of pertinent data, determining the appropriate approach for decision-making, and evaluating different alternatives. A decision support system is essentially an information system that supplies data, information, and modeling capabilities for data manipulation[7]. This system is used to assist decision making in semi-structured situations, where no one knows exactly how decisions should be made. Decision support systems aim to increase the effectiveness of decisions with computational speed that can increase productivity and decision quality so as to assist managers in making decisions[8].

B. Rescuer

A rescuer is an officer who works at the Indonesian Badan SAR Nasional (BASARNAS). The main task of a rescuer is to perform rescue or first aid on victims of natural disasters or accidents at sea, air and land. They are also trained in rescue techniques which include rescuing people trapped under collapsed buildings, stranded on remote islands, lost in forests or mountains, and many more. Rescuers themselves are equipped with modern rescue equipment and communication tools to help them in their rescue missions[9]. Some of the equipment includes diving equipment, land rescue equipment, and other supporting equipment such as vehicles, medical equipment, and others[10].

C. Basarnas Special Group

Basarnas Special Group personnel consist of selected BASARNAS personnel, known as BSG. A team of rescuers is assembled through a rigorous selection process that involves individuals from diverse work units within Basarnas. BSG is educated and trained to have special abilities in the field of search and rescue. Basarnas Special Group was formed to assist and accelerate the implementation of SAR operations in aviation, shipping, disaster and other disasters that are national in scale, or have a high level of difficulty.

D. Simple Multi Attribute Rating Technique Method (SMART)

The SMART Method is a technique for multi-attribute decision-making, which assists decision makers in selecting the most suitable alternative among several options. In this method, each decision maker is required to choose an alternative that aligns with the predetermined objectives[11].

According to [12], [13] The steps used for solving the Simple Multi Attribute Rating Technique (SMART) method are as follows:

1. Determine Criteria and Weights
   In order to establish the criteria employed in this decision-making system, it is necessary to obtain data from knowledgeable parties who possess expertise in the specific problem that needs to be addressed [14].
2. Then normalization is carried out. The formula used for weight normalization is as below:
   $$w_i = \frac{w'_i}{\sum_{j=1}^{m} w_j} \quad (1)$$
   Description:
   w_i : normalized criterion weight for the i-th criteria
   w'_i : weight of the i-th criteria
   w_j : j-th criteria weight
   j : 1,2,3, ... , m number of criteria
3. Calculate each utility value for each criterion respectively.
   $$u_i(a_i) = \frac{C_{max} - C_{min}}{C_{max} - C_{min}} \text{ x } 100 \quad (2)$$
   If Criteria is worth *benefit*
   $$u_i(a_i) = \frac{C_{out} - C_{min}}{C_{max} - C_{min}} \text{ x } 100 \quad (3)$$
   If Criteria is worth *cost*
   Description:
   $u_i(a_i)$: utility value of the i-th criteria for the i-th alternative
   c_{max} : maximum criteria score
   c_{min} : minimum criteria score
   c_{out} : i-th criteria value
4. Determining the Final Grade
   The final value is calculated by aggregating the collective outcomes of the utility value and the normalized weight value of the criteria.
   $$u(a_i) = \sum_{j=1}^{m} w_j * u_j(a_i) \quad (4)$$
   Description:
   $u(a_i)$: total value for the i-th alternative
   w_j : normalized jth criterion weight value
   $u_j(a_i)$: utility value of the jth criterion for the i-th alternative
5. Ranking
   After calculating the final value, the results are then arranged in descending order, with the alternative having the highest final value considered as the best alternative [15].

E. BORDA Method

BORDA method does not take into account the subjective views of the decision makers, which greatly influence the group's decision[16]. The Borda method is utilized to assess the complexity of the voting system election[17]. The Borda method is a method used in decision making for single winner and multiple winner elections, where voters rank the candidates based on the choice of data[18].

According to [16] The stages of solving a case using the Borda method are as follows:

1. In the decision-making process, each decision maker assigns a value of n-1 to the top-ranked alternative, a value of n-2 to the second-ranked alternative, and so on, with a value of 0 assigned to the least preferred alternative.
2. The alternative that obtains the highest cumulative score is declared as the winner.
3. For example: there are 3 alternatives with 9 voters

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Alternative: 2, 1, 0
4 sample where A > B > C A: 4x2+3x0+2x0 = 8 votes
3 sample where B > C > A B: 4x1+3x2+2x1 = 12 votes
2 sample where C > B > A C: 4x0+3x1+2x2 = 7 votes
Note: rank 1 is given a value of 2, rank 2 is given a value of 1, and rank 3 is given a value of 0. Where n = 3. The result is B as the winner.

F. Research & Development Method (R&D)

The R&D method is a research approach employed to develop products and assess their effectiveness through testing [19]. The stages carried out in the Research and Development method begin with researching and analyzing the needs or problems to be researched and then formulating a research plan by formulating problems, determining objectives, determining problem boundaries, conducting literature studies, and carrying out data collection with certain techniques[20].

G. Unified Modelling Language (UML)

UML (Unified Modeling Language) offers a set of language and modeling concepts, along with a user-friendly graphical notation, to facilitate the modeling of diverse application domains. It enables the specification, design, visualization, and documentation of software systems. The outcome of utilizing UML for modeling is a graphical representation comprising different diagrams that provide various perspectives of the system [21].

II. RESEARCH METHODOLOGY

A. Researh and Development Method (R&D)

In this research, the author collected data by interview, observation, and literature study. The explanation of the data sources is as follows:

1. Interview
   In this case the author conducted interviews with several employees of the Medan Class A Search and Rescue Office, such as the Head of General Subdivision, Head of Operations, Head of Resources, Advanced Rescuer, Advanced Staffing Analyst and Rescuer Supervisor regarding the criteria that determine the selection of rescuers.
2. Observation
   In this case the author makes direct observations at the Medan Class A Search and Rescue Office to obtain information.
3. Literature Study
   The data collection approach involved examining and investigating relevant books, online sources, journals and theses to identify the most suitable rescuers.

B. System Requirements Analysis

This stage is an analysis of system requirements by collecting data. This stage produces *user requirements* or *user desires* in making the system.

C. Design

At this stage aims to provide an overview of the appearance that will be done along with an overview of the stages that will be done. In the design stage the author uses UML (*Unified Model Language*) as system modeling, the UML used is: *Use Case Diagram*. In the design stage the author also describes the database design and interface design using Microsoft Visio 2019 which will later become a reference in making program code.

D. Program Design

Program code generation refers to the process of converting a design into a programming language that can be understood and executed by a computer. In this research, the author will make program code using the CSS programming language for the user interface with the Visual Studio Code text editor and the Hypertext Preprocessor programming language for implementing algorithms into the database using the local server XAMPP.

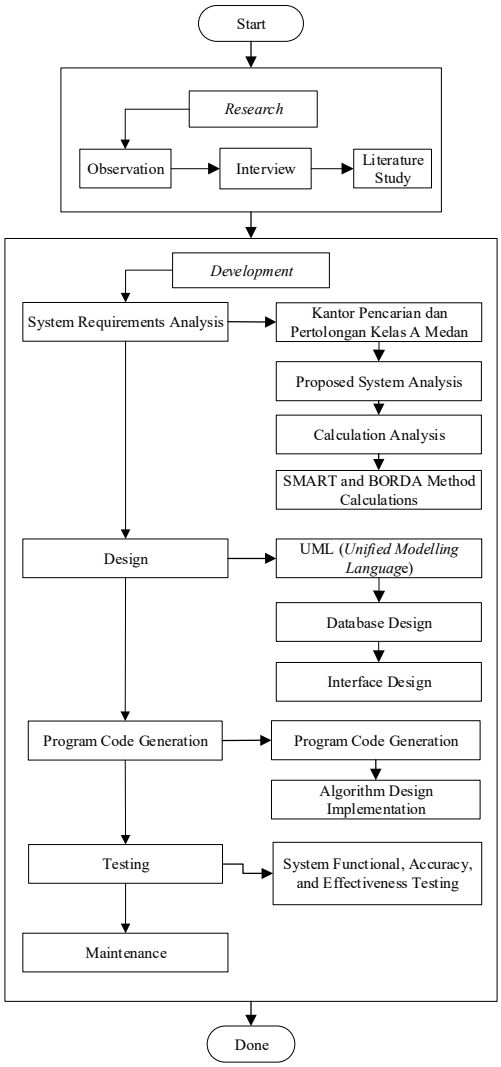

Fig1. R&D Method

E. Testing Techniques

At this stage, what is done for testing is testing the program to test the system completely according to the needs and find errors or bugs that may occur. At this stage the author will test the accuracy of system calculations with manual calculations to see the level of accuracy[22]. The product effectiveness testing stage is also carried out to see

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the success rate of a product or system that has been built[23].

F. Maintenance

At this stage, the system will be implemented to users and later the system will be carried out a maintenance process.

G. SMART and BORDA Method Algorithms

The SMART (Simple Multi Attribute Rating Technique) and BORDA method algorithms can be seen in the figure below:

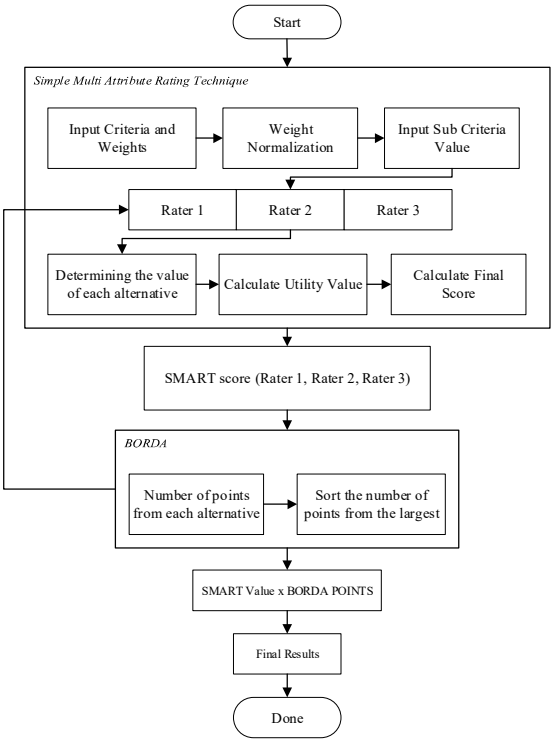

Fig 2. SMART and BORDA Method Algorithms

III. RESULTS AND DISCUSSION

The implementation of this system is carried out using two methods, namely weighting criteria using the SMART method, scoring with the BORDA method, and ranking with SMART scores and BORDA points.

A. Criteria and Weights

The criteria used in this decision support system are as follows:

Table 1. Criteria and Weights

No	Code	Criteria	Weight
1	K1	Fitness	35
2	K2	Physical Health	30
3	K3	Mental Health	25
4	K4	Creativity	20
Total			100

Determination of table 1 on the weight of the criteria obtained from BASARNAS. From table 1, it can be seen that there are 4 criteria that will be used as a benchmark for assessing BSG candidates in this study. And each criterion is shortened in letters and numbers such as K1 in table 1.

B. Normalization

After obtaining the weight value for each criterion, then the normalization calculation is carried out, normalization is carried out by dividing the weight value of the criteria by the total weight.

Table 3. Normalization

No	Code	Weight Normalization	Total
1	K1	35/100	0,35
2	K2	25/100	0,25
3	K3	25/100	0,25
4	K4	15/100	0,15

C. Sub-Criteria Score

Table 2. Sub-Criteria

No	Criteria	Sub-Criteria	Value
1	Fitness	Very Masterful	12
		Mastering	6
		Not Mastering	4
		Very Poorly Mastered	2
2	Physical Health	Very Good	12
		Good	6
		Not Good	4
		Not Very Good	2
3	Mental Health	Very Good	12
		Good	6
		Not Good	4
		Not Very Good	2
4	Creativity	Very Creative	12
		Creative	6
		Not Creative	4
		Very Uncreative	2

D. Utility Value

The data used has two job titles, Rescuer-T is Skilled Rescuer, and Rescuer-P is Beginner Rescuer. As there are 3 raters, only one will be assessed to calculate the utility value, the following table is a fraction of the overall BSG candidate data:

Table 4. BSG Candidate Data

No	Sample	K1	K2	K3	K4
1	Rescuer-T 1	12	6	6	6
2	Rescuer-T 2	12	6	12	6
3	Rescuer-T 3	12	12	12	6
…	…..	…	…	…	…
25	Rescuer-P 5	12	6	4	2

Table 4 is a change in the number of BSG candidate assessments. From these changes, we can see the maximum value and minimum value that will then be determined.

Table 5. Minimum and Maximum Values

Value Category	K1	K2	K3	K4
Minimum Value	2	2	4	2
Maximum Value	12	12	12	12

After obtaining the maximum and minimum values, the utility value is calculated with alternative values using the theory with the benefit equation as below.

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$$u_{(Rescuer-T1)}(K1) = \frac{(12-2)}{(12-2)} x100 = 100 \qquad u_{(Rescuer-T2)}(K1) = \frac{(12-2)}{(12-2)} x100 = 100$$

$$u_{(Rescuer-T\ )}(K2) = \frac{(6-2)}{(12-2)} x100 = 40 \qquad u_{(Rescuer-T2)}(K2) = \frac{(6-2)}{(12-2)} x100 = 40$$

$$u_{(Rescuer-T1)}(K3) = \frac{(6-4)}{(12-4)} x100 = 25 \qquad u_{(Rescuer-T2)}(K3) = \frac{(12-4)}{(12-4)} x100 = 100$$

$$u_{(Rescuer-T\ )}(K4) = \frac{(6-2)}{(12-2)} x100 = 40 \qquad u_{(Rescuer-T2)}(K4) = \frac{(6-2)}{(12-2)} x100 = 40$$

$$u_{(Rescuer-T3)}(K1) = \frac{(12-2)}{(12-2)} x100 = 100 \qquad u_{(Rescuer-P5)}(K1) = \frac{(12-2)}{(12-2)} x100 = 100$$

$$u_{(Rescuer-T3)}(K2) = \frac{(12-2)}{(12-2)} x100 = 100 \qquad u_{(Rescuer-P5)}(K2) = \frac{(6-2)}{(12-2)} x100 = 40$$

$$u_{(Rescuer-T3)}(K3) = \frac{(12-4)}{(12-4)} x100 = 100 \qquad u_{(Rescuer-P\ )}(K3) = \frac{(4-4)}{(12-4)} x100 = 0$$

$$u_{(Rescuer-T3)}(K4) = \frac{(6-2)}{(12-2)} x100 = 40 \qquad u_{(Rescuer-P5)}(K4) = \frac{(2-2)}{(12-2)} x100 = 0$$

Table 6. Utility Value Result

No	Sample	K1	K2	K3	K4
1	Rescuer-T 1	100	40	25	40
2	Rescuer-T 2	100	40	100	40
3	Rescuer-T 3	100	100	100	40
…	…..	…	…	…	…
25	Rescuer-P 5	100	40	20	0

E. Final Grade Determination

To determine the final score, the normalized value is multiplied by the utility value as below.

Table 7. Results of the Final Value of Rater I

No	Sample	K1	K2	K3	K4
1	Rescuer-T 1	0,35x100=35	0,25x40=10	0,25x25=6,25	0,15x40=6
2	Rescuer-T 2	0,35x100=35	0,25x40=10	0,25x100=25	0,15x40=6
3	Rescuer-T 3	0,35x100=35	0,25x100=25	0,25x100=25	0,15x40=6
…	…..	…	…	…	…
25	Rescuer-P 5	0,35x100=35	0,25x40=10	0,25x0=0	0,15x0=0

Table 8. Rating Results of Rater I

No	Sampel	K1	K2	K3	K4	SMART Value
1	Rescuer-T 1	35	10	6,25	6	57,25
2	Rescuer-T 2	35	10	25	6	76,00
3	Rescuer-T 3	35	25	25	6	91,00
4	Rescuer-T 4	14	10	6,25	3	33,25
5	Rescuer-T 5	14	10	6,25	6	36,25
6	Rescuer-T 6	35	25	6,25	6	72,25
7	Rescuer-T 7	35	25	6,25	15	81,25
8	Rescuer-T 8	14	10	6,25	3	33,25
9	Rescuer-T 9	35	10	6,25	3	54,25
10	Rescuer-T 10	35	0	6,25	6	47,25
11	Rescuer-T 11	14	10	25	6	55,00
12	Rescuer-T 12	35	5	6,25	6	52,25
13	Rescuer-T 13	14	10	25	3	52,00
14	Rescuer-T 14	35	25	6,25	6	72,25
15	Rescuer-T 15	35	25	25	15	100,00
16	Rescuer-T 16	14	10	25	15	64,00
17	Rescuer-T 17	14	25	6,25	3	48,25
18	Rescuer-T 18	35	10	6,25	3	54,25
19	Rescuer-T 19	35	5	6,25	6	52,25
20	Rescuer-T 20	35	10	6,25	3	54,25
21	Rescuer-P 1	14	5	6,25	0	25,25
22	Rescuer-P 2	7	10	6,25	3	26,25
23	Rescuer-P 3	0	10	6,25	3	19,25
24	Rescuer-P 4	14	25	0	0	39,00
25	Rescuer-P 5	35	10	0	0	45,00

F. Poin BORDA

The SMART value that has been obtained is multiplied by BORDA points with the Tournament Style with the highest rank getting the largest value with the number n or the number of alternatives, the next rank will get n-1, n-2 and so on.

Table 9. Results of BORDA Points Rater I

No	Sample	SMART Value	Point BORDA	Total
1	Rescuer-T15	100,00	25	2500,00
2	Rescuer-T3	91,00	24	2184,00
3	Rescuer-T7	81,25	23	1868,75
…	…..	…	…	…
25	Rescuer-P3	19,25	1	19,25

G. SMART and BORDA Calculation Results for All Assessors

The total of the SMART and BORDA multiplication, summed by several raters, gives the final score, which can determine who is eligible to become a BSG candidate.

Table 10. Ranking Result

Rank	Sample	Rater I	Rater II	Rater III	Total
1	Rescuer-T15	2500,00	1518,00	2031,25	6049,25
2	Rescuer-T3	2184,00	1584,00	2031,25	5799,25
3	Rescuer-T7	1868,75	1086,75	1770,00	4725,50
4	Rescuer-T2	1672,00	795,00	992,25	3459,25
5	Rescuer-T6	1445,00	514,50	573,75	2533,25
6	Rescuer-T19	903,00	679,25	675,75	2258,00
7	Rescuer-T14	1517,25	47,00	636,00	2200,25
8	Rescuer-T1	1030,50	231,00	840,75	2102,25
9	Rescuer-T4	1012,00	133,00	715,50	1860,50
10	Rescuer-T17	920,00	482,50	332,50	1735,00
11	Rescuer-T10	1039,50	88,50	425,25	1553,25
12	Rescuer-T16	1216,00	126,00	210,00	1552,00
13	Rescuer-T20	868,00	390,00	273,00	1531,00
14	Rescuer-T9	759,50	59,00	661,50	1480,00
15	Rescuer-T12	722,00	108,00	627,00	1457,00
16	Rescuer-T11	935,00	189,00	285,00	1409,00
17	Rescuer-T13	572,00	570,00	73,75	1215,75
18	Rescuer-T18	813,75	210,00	105,00	1128,75
19	Rescuer-T5	480,00	217,50	189,00	886,50
20	Rescuer-P5	360,00	144,00	252,00	756,00
21	Rescuer-T8	356,25	231,00	166,25	753,50
22	Rescuer-P4	273,00	27,75	144,00	444,75
23	Rescuer-P1	50,50	75,00	12,50	138,00
24	Rescuer-P2	78,75	17,50	3,00	99,25
25	Rescuer-P3	19,25	8,75	27,75	55,75

In this manual calculation, it is found that Rescuer-T15 deserves to be a BSG candidate with a total score of 6049.25 and Rescuer-P5 who got the highest score at the beginner level with a score of 756.00.

H. Usecase Diagram SMART & BORDA

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In the Use Case Diagram below, there are 4 actors who play a role in the course of the program.

The first actor is the admin, the admin can perform the login logout process, manage data such as criteria data, sub-criteria, weights, rater reminders, manage users and SMART & BORDA reports.

The second, third and fourth actors are Appraisers I, II, and III, in this system appraisers can log in, dashboard, view SMART&BORDA reports, and conduct assessments.

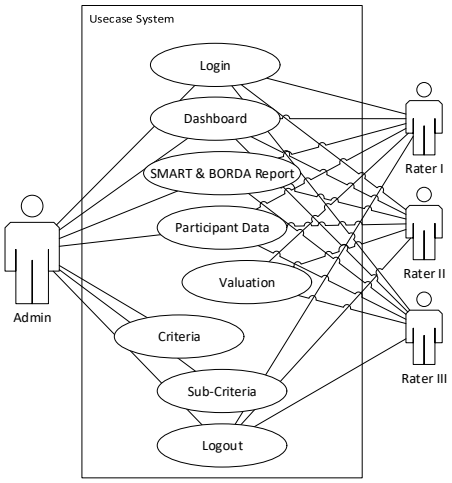

Fig 3. Usecase Diagram SMART&BORDA

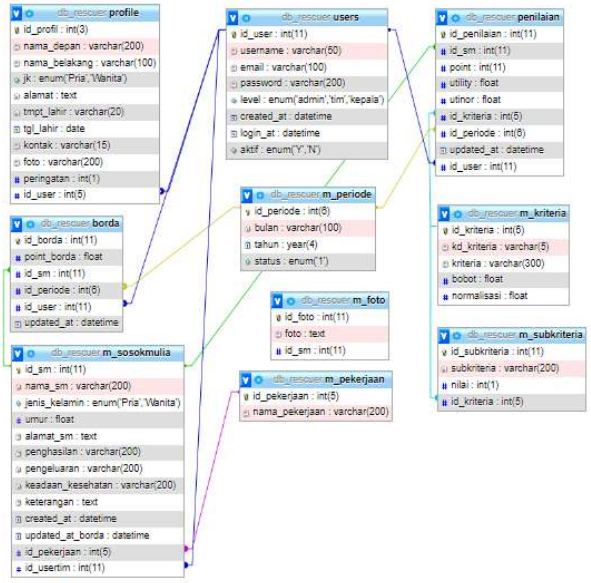

Fig4. Database Design

And this is the database design to create a PHP-based BSG candidate selection decision support system.

I. Implementation System

In making a web system, the author uses the PHP programming language and MySQL database. The following is a view of the web-based system.

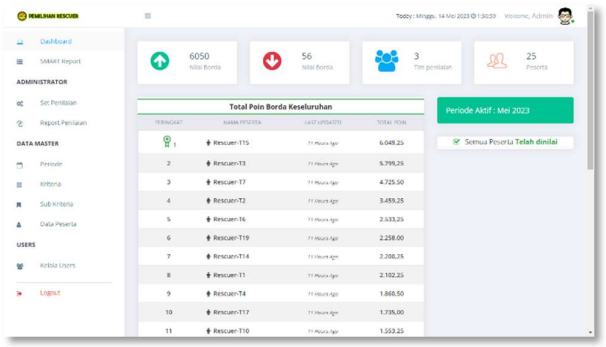

Fig 5. Dashboard Page

The dashboard page directly displays the assessment ranking from highest to lowest, there is also an assessment team and participants who become BSG candidates.

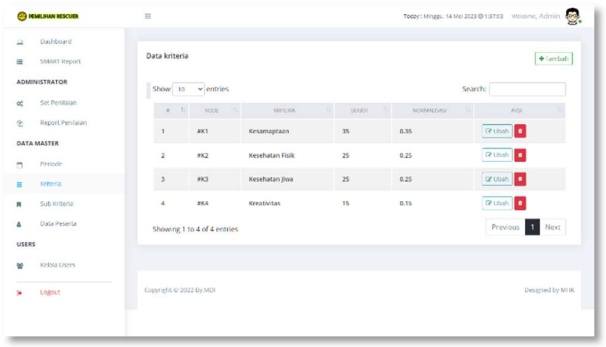

Fig 6. Criteria Page

On the criteria page there are CRUD functions, such as adding, editing and deleting. As well as the weights that have been input directly normalized with the overall weight.

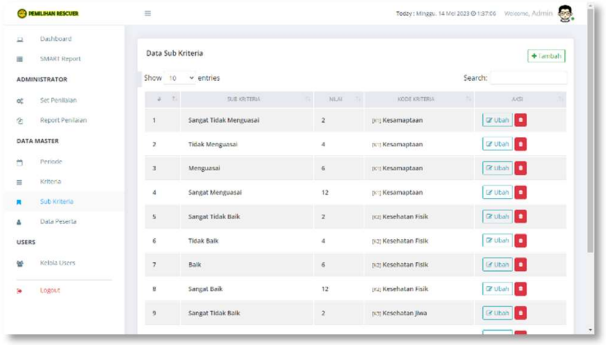

Fig 7. Sub-Criteria Page

On this page, you can create and assess several sub-criteria in Figure 7 above.

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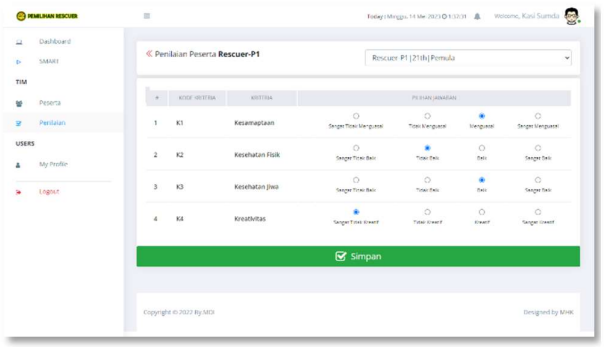

Fig 8. Valuation Page

This page is an assessment page, an example of an assessment as in Figure 8 above, the assessor only needs to click on the assessment criteria that match the participant.

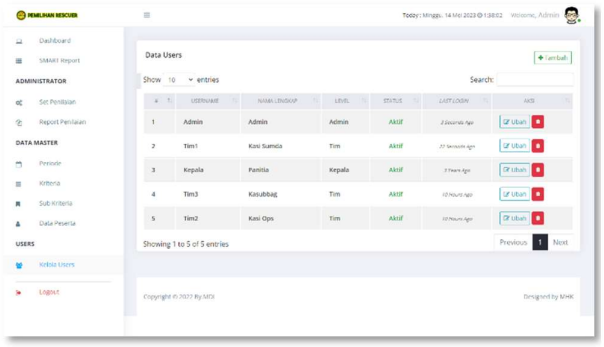

Fig 9. Manage Users Page

Admins are able to manage existing users such as assessors, able to change usernames, passwords and delete them.

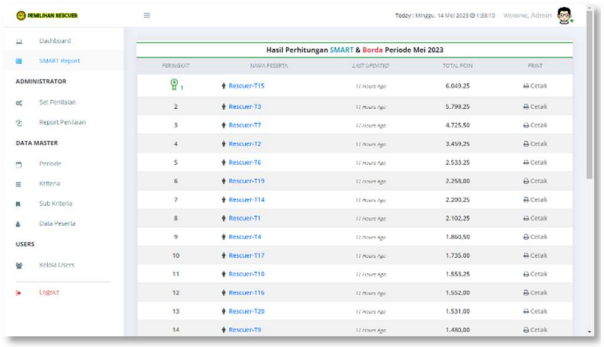

Fig 10. SMART and BORDA calculations

On the SMART Report menu, we can see the highest to lowest rankings. The rankings are obtained from the assessment by the assessment team.

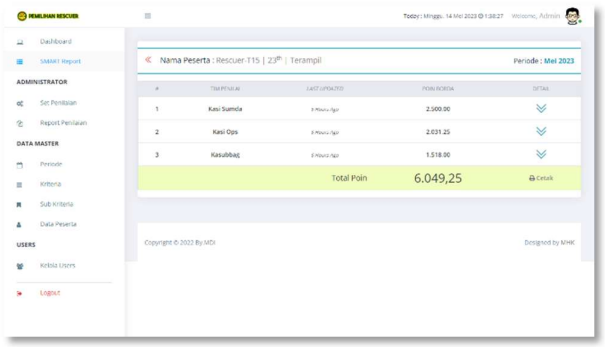

Fig 11. Total Per-Individual Page

Participants who click on their name on the SMART Report will appear like this, with details of assessors I, II, and III as in Figure 11 above.

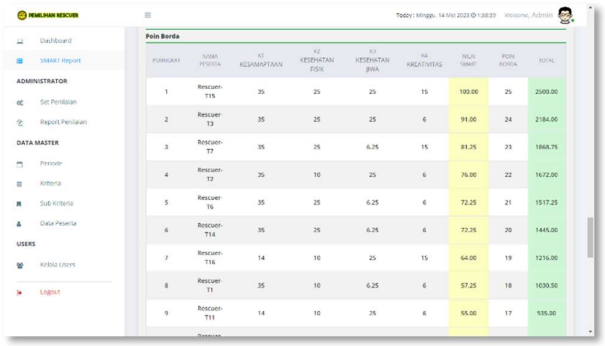

Fig 12. SMART Value x BORDA Point Page

When the SMART value is obtained, it will be multiplied by borda points according to the number n, the results are automatically ranked.

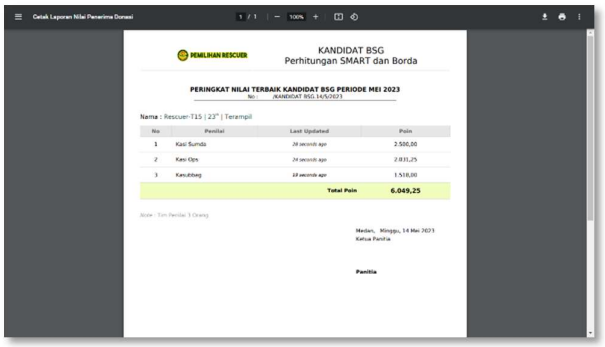

Fig13. Print Per-Individual Page

Print results for each individual can be seen in the image above.

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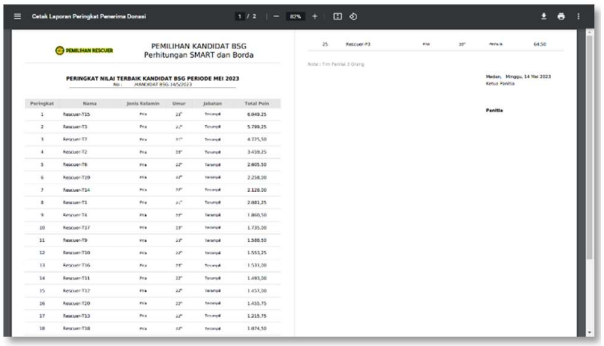

Fig 14. Print All Page

And this is the whole print page, the print results obtained are in PDF format. In this system calculation, it is also found that Rescuer-T15 deserves to be a BSG candidate with a total score of 6049.25 and Rescuer-P5 who got the highest score at the beginner level with a score of 756.00.

IV. CONCLUSION

The results of the use of the SMART and BORDA methods in the selection of Basarnas Special Group candidates based on criteria, namely, Kesamaptaan, Kesehatan Fisik, Kesehatan Jiwa and Kreatifitas. The final result obtained is that the best BSG candidate is obtained on predetermined criteria. Based on the overall results of manual and system calculations in the program above, Rescuer-T15 and Rescuer-P5 are the highest alternatives in skilled and beginner positions.

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The Impact of Technology on Students' Psychological and Educational Performance

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Abstract – The quality, availability, consistency, and accessibility of technology play vital roles in shaping learning performance and effectiveness. However, it is important to recognize that technology alone does not guarantee desired learning outcomes. Instead, the interaction between humans and technology, along with the design dimensions of educational tools, significantly influence students' learning outcomes and their psychological engagement with the learning process. Moreover, improper utilization of technology can pose obstacles to effective learning. This paper aims to provide a thorough examination of the effects of technology on the learning process, aiming to identify instances where technology serves as a facilitator or hindrance to learners. Furthermore, a diverse range of suggestions will be presented to optimize and enhance the role of technology in promoting effective learning experiences. The research highlighted the advantages and disadvantages of different technology aspects on students, and highlighted how keeping the learning outcome as a principle in course design will lead to the proper evaluation of learning outcome. By delving into these crucial aspects, this research endeavors to provide valuable insights and actionable recommendations for educators, policymakers, and stakeholders seeking to harness the full potential of technology in education.

Keywords – Technology, Learning Outcomes, Self-Efficacy, E-Learning

I. INTRODUCTION

Computer technologies have shaped our society over the past few decades, altering many parts of our life, including the way we interact with one another at home and at work [1]. Technology and computers are frequently promoted as having a positive impact on student motivation. During the 2020 pandemic, remote learning became more prevalent and eventually took over as the primary teaching method. These compliments, however, are frequently made without taking into account the particular features or uses of these technologies that serve as the inspiration for them. In this article, technological aspects are discussed together with their advantages and disadvantages, followed by suggestions for improving the usability of technology [2]. Earlier, the teaching-learning process is dominated by the role of the teacher, because it is called the era of teacher. Now, the teaching-learning process, are dominated by the role of lecturers and books, and on the future of teaching and learning process will be controlled by teachers, books, and technology. Hence, the scientific aspects has been changed due to technology as the psychological aspects, and both will be explored in this research.

II. RESEARCH METHODOLOGY

To understand the impact of technology on students, it has been divided to scientific and psychological aspects.

1. Scientific Aspects:

Internet represents one of the most important fields in which the technology involves with education, it is used as an instructor that the internet can improve knowledge about any subject matter. Internet use may improve knowledge of a subject and enhance understanding. It can also help students who have trouble studying in class grasp a subject that they found challenging while learning on their own. The Internet may increase the appeal of learning, improve attempts to provide the best learning results, and inspire a spirit of learning. By integrating internet learning initiatives, it can also lessen the tendency of asking friends for assistance [2].

The Internet may be used to quickly address all learning challenges, the going on the subject matter, and the going on difficulties [2]. Internet media can be used as mental tools for thinking and problem-solving to assist in finishing the mission of the school.

Through the use of the internet, network project communication is defined by academic and social contacts with colleagues and scientists, including the sharing of scientific information, recollections, and observations. These conversations provide chances for friendship and a deeper appreciation of other people's opinions. If properly enabled, cooperation is an efficient way to boost student success and motivation to learn, according to research on the social production of knowledge. The requirement for knowledge from others to accomplish project goals, such as the need to synthesis multiple data sets to discover patterns, frequently encourages collaboration [1].

Technology can replace or supplement the conventional function of printed materials as a means of content transmission by offering animation, computer-based tutorials, and richer and more dynamic information displays [3]. Technology may help students communicate with one another as a communication tool [4], increase instructor accessibility outside of scheduled classes and office hours, and complete administrative tasks like

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distributing course materials. According to researches, instructor-student interactions are twice as significant as student-student interactions (when they occur) [5][6].

2. Psychological Aspects of Using Technology in Education

Online discussions are frequently more fun for students who struggle with social anxiety [7] because they ease their concerns about receiving unfavorable feedback from others. Students may be more able to be themselves in asynchronous online conversations, but there are hazards associated with self-disclosure, thus they must be cautioned about this potential consequence and the online discussion board should be set up so that students may erase their own messages[8][9]. Self-efficacy is seen as a key element that motivates students to participate more actively in the learning environment, especially online learning.

Self-Efficacy:

According to Bandura [10], self-efficacy affects a variety of characteristics of learning, including as a person's choice of activities, effort, perseverance, and task successes.

Shunk and Hanson[11] talked about how seeing people behave well who are seen as being similar to you increases self-efficacy and encourages viewers to attempt or endure longer. Therefore, by using these online tools, people may locate peers who share many of their traits and who they can learn from as they succeed. According to studies, self-efficacy acts as a mediator between an individual and his or her conduct.

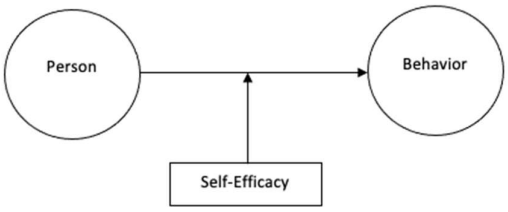

Fig 1. Self-Efficacy Mediates Students' Behavior [12]

Self-efficacy that leads to spend more time on a task indicates high confidence and enthusiasm in learning. The students' ability to locate a learning setting where their voices and those of their classmates were appreciated and respected, allowing them to regard themselves as effective participants in this new learning circumstance, was thought to be at least largely responsible for this change in emphasis. The confidence of students may be applied to other facets of their lives. Additionally, the Internet offers students the chance to employ professional-grade research and analytic tools. The real activities found in networked projects appear to have a favorable effect on student motivation, according to at least some research [1].

3. Limitations of Using Technologies

Despite the benefits of technology, studies show that students spend less time trying to analyze or evaluate the material they discover and instead concentrate on getting rapid responses and giving information a superficial interpretation [1]. Additionally, the internet makes it easy to find various answers, which reduces how much learners understand. Additionally, there is a risk of injury since it is simple for children to find websites with negative intents [9][8], such as bullying, blackmail, and give rude criticism that is not often addressed in personal conversation. The advantages and disadvantages of various technological services in the learning process are shown in Table 1.

Table1: Technology and its positive and Negative potentials in learning

Technology	Advantage	Disadvantage
Reading Contents Online	Wide availability of knowledge	Distraction
Studying using Mobile phones/Tablets	Flexibility of contents, easy search and highlight	Seeing devices as for entertainment not for study Long screen time
Communicating with Collogues	Have active environment and discussions	Chatting and wasting time
Self-expressing	Release pressure	Bullying
Recorded Lectures	Flexibility in time	Procrastination, active participation Lack of instructor-Student interaction

III. DISCUSSION AND ANALYSIS

In this section, several scientific and psychological aspects of enhancing the process of using technology are explored, including self-efficacy, technology-related teaching environment, revising technology usage, considering conscious and subconscious mind, and exploring learning outcome.

1. Enhancing Self-Efficacy

The definition of academic self-efficacy beliefs is assessments of one's capacity to achieve in academic endeavors. Students that have more self-efficacy will work harder and be more motivated. Higher expectations and values should be held by students for their academic performance [10][13]. And to accomplish this it is required to describe the significance of the subjects taught and make a connection between them and lives, habits, and aims of the students. In addition, it should be active, centered on motivating students, and flexible enough to let teachers choose the right assessments and assignments for individuals. Artificial intelligence (AI), for instance, may be utilized to assess the pupils' areas of strength and provide relevant scientific resources.

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2. Design a Suitable Environment

It's important to provide a setting where students may explore and reflect in safety on their comprehension of delicate subjects. Students may develop self-doubt or low self-esteem as a result of thinking about how important their own action is and how they grasp the implications and consequences of it. Students should feel free to express any disturbing feelings in a secure place [8]. Other factors were addressed in [14], such as the necessity for a motivating component, feedback, and a learning atmosphere that encourages students to ask questions in order to increase their interest in the subject. Online learning should also provide new avenues for access to education; therefore, it shouldn't restrict the availability of educational materials to only documents or presentations. Online students deserve more than just reading texts via the Internet. They could learn through videos, games or even augmented reality (AR) and virtual reality (VR).

3. Review Technology Use at The Educational Institutions

According to common sense, we must first determine whether the new technology phenomena is related to current practices before examining the viability of its application. To put it another way, educational institutions need to make certain that they comprehend new technology and whether or not it would be a better match than what we already have. Furthermore, will its implementation actually help the organization? If the new technology hasn't been sufficiently researched and comprehended, at the very least, be aware of its drawbacks [15].

4. Considering Conscious and Sub-Conscious minds

People have seen into the realm of cyberspace using their conscious and/or subconscious minds [16]. To encourage and prod individuals into acting in accordance with their desires on the Internet, the conscious mind is required. To build an atmosphere in the mind for what individuals wish to feel and envision via the Internet, the subconscious mind is required. This explains what visitors like and dislike about a specific location [17]. When working with young students, these characteristics need to be examined and connected to technology.

5. Considering learning outcome

One of the most important ideas to have better usage of technology is to think about the outcome from the beginning of course design, i.e., to get benefits of a class or a training, it's important to have clear objectives and learning outcomes to be to measure the expected results out of that learning experience. The main difference between learning objective and learning outcome is that learning objective focus on learners while learning objective focus on the teacher activities during learning process to achieve learning outcomes. Without setting clear learning outcomes before starting a course it will be not clear how this course will impact the learners. learning outcome can be classified into three groups [18]:

Psychomotor Outcomes: The psychomotor outcomes include efficiency, accuracy, and response magnitude [19] . Many studies tried to improve psychomotor outcome by using certain technologies, for example a study [20] used Leap Motion technology that enables humans to interact with object by moving it by their own hand. The 3D blocks are called objects in this study. Users can put the block into different positions to arrange objects to form new shapes. Another study [21], concluded that outcomes relating to psychomotor skills implementation improve the usage of VR as an educational involvement. That study was trying to answer the question of how VR simulation compare to simulated practice could help in the possession of getting psychomotor skills for pre-registration student nurses?

In other study [22] it recommends the use of robots and simulation software to teach engineering courses related to Robots, the study used a questionnaire for 40 students and asked them questions related to the acquired affective and psychomotor skills. Using simulation technology could improve psychomotor skills more than conventional labs sometimes according to study focused on using simulation in electronic technology courses [23]. In summary, many research work around the world suggest that using technology have potentials related to psychomotor skills.

Cognitive Outcomes: include knowledge, comprehension, application, and analysis[24]. Using latest features of technology can improve assessments of cognitive skills and make it more accurate [25], this is what is suggested by this study which was conducted in Saudi Arabia. The use of a mobile applications for simulation learning has helpful influence on nursing students' knowledge and skill performances as thus improving of learning cognitive outcomes [26]. Another study [27], suggested that technology could offer cognitive skills enhancement, in addition to improve everyday life quality for example using online and mobile apps for cognitive behavioral therapy, AI voice technologies such as Alexa which can support human-machine conversations to decrease loneliness and depression. Last but not least, a study confirmed that using cognitive simulation technology confirmed the efficiency of technology in teaching social and humanitarian topics [28].

Affective Outcomes: include students' perception of satisfaction, attitude, and appreciation for the learning experience. According to this paper [29], a positive affect has a crucial role in behavioral in technology adoption, hence continuous enhancement on the technological tools is required to generate positive affect on the learners.

IV. CONCLUSION

This research paper provides an in-depth examination and analysis of the diverse advantages and disadvantages

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associated with technology integration in education. Emphasizing the significance of considering factors such as student personality and learning outcomes, it underscores the need to carefully select appropriate technological schemes. Each technological solution presents its own distinct set of pros and cons, highlighting the existence of both positive and negative applications. It is imperative for educational institutions, managers, lecturers, and students to have a clear understanding of their objectives when incorporating technology and to utilize it effectively. By thoroughly exploring these considerations, this study aims to offer valuable insights that enable informed decision-making regarding technology integration in education. Ultimately, the research endeavors to optimize the benefits of technology while mitigating potential drawbacks, resulting in an enhanced learning experience for all stakeholders involved.

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