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Decision Support System for Determining Lecturer Scholarships for Doctoral Study using CBR (Case-Based Reasoning) Method

Tri Susilowati, P. Manickam, G. Devika, K. Shankar, Latifah, Muhamad Muslihudin, Wahidah Hashim, Miftachul Huda, Aleksandr Aleeksevich Korostelev, Andino Maseleno

Abstract*: Selection of lecturers of Scholarship Recipients is the recognition of lecturers who actually and extraordinarily carry out tridharma activities of higher education that the results can be proud of and beneficial for the advancement of academic and institutional quality improvement. The selection of scholarship recipients at the STMIK Pringsewu is conducted annually. In the assessment process of scholarship recipients, STMIK appoints an assessment team to assess lecturer candidates. However, the assessment process is still done manually so that it takes a long time to process data. In addition, the assessment is still subjective and not relevant to the actual situation. Based on this, the Decision Making Planning of Determining the STMIK Pringsewu Lecturer Scholarship for Doctoral Study Using CBR (Case Based Reasoning) Method was established. Decision support systems built on the web using PHP and MySQL programming languages as databases. The decision-making method used is the Case Based Reasoning (CBR) method. This method is used to determine the weight value of each criterion, which is then carried out the ranking process to determine the best alternative from a number of alternatives. Tests conducted in this study are functional testing with the black box testing method. The test results indicate that the system can run well according to its function.

***Index Terms*: Outstanding lecturers, lecturer scholarships, Case Based Reasoning, decision support systems**

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***** Correspondence Author
Tri Susilowati*, Department of Information Systems, STMIK Pringsewu, Lampung, Indonesia.
P. Manickam, School of Computing, Kalasalingam Academy of Research and Education, Krishnankoil, India.
G. Devika, School of Computing, Kalasalingam Academy of Research and Education, Krishnankoil, India.
K. Shankar, School of Computing, Kalasalingam Academy of Research and Education, Krishnankoil, India.
Latifah, Department of Information Systems, STMIK Pringsewu, Lampung, Indonesia.
Muhamad Muslihudin, Department of Information Systems, STMIK Pringsewu, Lampung, Indonesia.
Wahidah Hashim, Institute of Informatics and Computing Energy, Universiti Tenaga Nasional, Malaysia.
Miftachul Huda, Universiti Teknologi Malaysia, Malaysia.
Aleksandr Aleeksevich Korostelev, Togliatti State University, Russia.
Andino Maseleno, Institute of Informatics and Computing Energy, Universiti Tenaga Nasional, Malaysia.

I. INTRODUCTION

A. Background

Higher Education is one of the important pillars in the development of a nation. As the highest level of education in the national education system, higher education is a reference in encouraging the development of a nation. Higher education in Indonesia is a national education subsystem which includes diploma, undergraduate, master, specialist and doctoral programs organized by Universities. Higher Education is obliged to carry out education, research and community service [1].

One element in the administration of higher education is a lecturer. Lecturers are academic staff who are tasked with planning and implementing the learning process, assessing learning outcomes, conducting guidance and training, and conducting research and community service. Based on the Law of the Republic of Indonesia Number 14 of 2005 concerning Teachers and Lecturers, Article 51 Paragraph (1) Item b, that lecturers are entitled to get promotions and awards in accordance with their academic performance [1]. This reward system related to aspirations and motivation among lecturers is expected to be one of the ways in developing academic management in each university.

STMIK Pringsewu is a College of Information and Computer Management located in South Lampung, Pringsewu Regency which always strives to continuously improve internal quality so that it can compete with other college. One of the efforts already done is by selecting outstanding lecturers who will get a Doctoral scholarship every year. Lecturers who are selected as outstanding lecturers will receive financial rewards and non-financial rewards. The selected lecturers also had the opportunity to get a Doctoral scholarship to continue their education.

In the process of assessing outstanding lecturers, an assessment team is appointed to assess the lecturer candidates. However, the assessment process is still carried out manually and implemented in paper form, so that it takes a long time to process data. In addition, the assessment is still subjective and not relevant to the actual situation, so it cannot be used as a basis for decision making.

To overcome this problem, a decision support system is needed to determine the decisions taken [2-5]. Decision support systems are interactive information systems that provide information, modeling, and manipulating data [6-10].

This system is used to help decision making in semi-structured situations and unstructured situations [11-15].

In this study, the use of the Case Based Reasoning (CBR) method was used. This method was chosen because it can determine the weight value of each criterion, which is then carried out the ranking process to determine the best alternative from a number of alternatives. With the ranking method, it is expected that the assessment can be more precise because it is based on the criteria and weight values that have been determined so that it gets a more accurate assessment of who gets the title of outstanding lecturer.

Based on the background above, in this study six criteria were determined in this case study: Age, GPA, Achievement, Discipline, Work Loyalty, TOEFL Score. The system is expected to help and improve the performance of the assessment team in the selection process to choose who is entitled to receive the Doctoral scholarship at STMIK Pringsewu.

B. Problem Formulation

Based on the background described above, the formulation of the problem of this research is how to build a decision support system determining the outstanding lecturers who are eligible to receive Doctoral Scholarships at STMIK Pringsewu using the CBR (Case-Based Reasoning) method to solve the problem of determining the outstanding lecturer, so that the selection process can take place more quickly and precisely and minimize the occurrence of subjective and irrelevant assessments.

C. Problem Limitation

The problem limitation of this study are :

1. The system developed is a decision support system for selecting lecturers with the CBR (Case Based Reasoning) method
2. Decision support systems built on the web using the PHP, HTML and MySQL programming languages as the database.
3. Determination of outstanding lecturers based on criteria that have been determined by the Directorate General of Higher Education, through the book "General Guidelines for Outstanding Lecturer Selection" in 2014.
4. System development method using SDLC framework with the method used is the Waterfall method.

D. Objective

The objective of this study was to make a decision-making plan to determine the scholarship for the STMIK Pringsewu lecturers for Doctoral using the CBR and SAW methods to help solve the problem of determining scholarship recipients so that the selection process can take place faster and appropriate and minimize the occurrence of subjective and irrelevant judgments.

E. Benefit

The benefits of this study are as follows:

1. Provide convenience for the assessment team in carrying out the selection of outstanding lecturers who receive scholarships.
2. Can replace the selection of outstanding lecturers who still use the manual method and the database used is still in the form of paper, thus becoming a computerized selection process.
3. Provide guarantees of feasibility results in the selection process of outstanding lecturers.
4. Increase knowledge about decision making models, one of them is CBR (Case Based Reasoning).

II LITERATURE REVIEW

A. Selection of Scholarship Recipients

This reward system related to aspirations and motivation among lecturers is expected to be one of the ways in developing academic management in each university. In addition, the reward system is an important element and has a role in developing an academic atmosphere, which in turn can accelerate the development of the scientific community of the present and the future as expected. This reward system must be in line and in accordance with the dignity of the lecturer as digger and developer of science, technology, and art and culture, researchers and community service [1].

B. Decision Support System

The Decision Support System (DSS) is an interactive information system that provides information, modeling, and manipulating data. This system is used to help decision-making in semi-structured situations and unstructured situations, where no one knows exactly how a decision should be made [16-22]

The opinion of some experts that the Decision Support System (DSS) is made to improve the process and quality of decision making, where DSS can integrate data and knowledge to improve effectiveness and efficiency in the decision making process [23- 26]

Decision support system is an addictive, interactive, flexible computer-based information system specifically developed to support solutions to unstructured management problems to improve the quality of decision making. Thus one definition can be drawn about the decision support system, namely a computer-based system that is adaptive, flexible, and interactive that is used to solve unstructured problems so as to increase the value of decisions taken [27-30].

C. Step of Decision Making

To produce good decisions there are several stages of the process that must be passed in structured, semi-structured, or unstructured decision making.

The decision-making process through the following stages:

1. Search Step

At this stage, decision makers learn the facts that occur, so that we can identify the problems that occur are usually carried out an analysis of the system to the forming subsystem so that the output is obtained in the form of a problem statement document [31-47].

2. Design Step

In this stage, decision makers find, develop and analyze all possible solutions, namely through the creation of models that can represent the real conditions of the problem. From this stage the output is obtained in the form of alternative solution documents [48-55].

3. Choice Step

At this stage, decision makers choose one of the alternative solutions made at the design stage which is seen as the most appropriate action to overcome the problem at hand. From this stage, the solution document and the implementation plan are obtained [56-65].

4. Implementation Step

The decision maker runs the solving action series selected in the choice stage. Successful implementation is marked by the problem being faced, while failure is marked by the problem that is still being tried to overcome. From this stage, a report on the implementation of the solution and the results was obtained [66-70]

D. Components of Decision Support System

Decision Support Systems consist of four subsystems, namely:

1. Data Management, includes databases that contain data which relevant to the situation and managed by software called Database Management System (DBMS).
2. Management Model is a software package that contains financial models, statistics, management science, or quantitative models, which provide analytical skills and appropriate management software.
3. Dialog or communication subsystem, is a subsystem used by the user to communicate and give commands (providing a user interface).
4. Knowledge Management that supports other subsystems or acts as a stand-alone component. This component can provide the expertise needed to solve several aspects of the problem and provide knowledge that can improve the operation of other decision support system components.

Based on all these definitions, decision support systems must include three main components, namely the DBMS (Database Management System), model management and user interface. Knowledge management subsystem is optional but can provide many benefits because it provides intelligence for the three main components.

E. Characteristics of Decision Support System

The role of decision support systems in the context of the overall information system is intended to improve performance through information technology applications.

The following characteristics are expected to exist in decision support system :

1. Support for decision makers, especially in semi-structured and unstructured situations, by including human assessment and computerized information.
2. Support for all managerial levels, from top executives to line managers.
3. Support for individuals and groups.
4. Support for independent and sequential decisions. Decisions can be made once, several times, or repeatedly (in the same interval).
5. Support in all phases of the decision making process: intelligence, design, choice and implementation.
6. Support in various processes and styles of decision makers.
7. Adaptivity all the time.
8. Users feel like home.
9. Increased decision-making effectiveness (accuracy, timelines, quality) rather than increasing efficiency (cost of decision making).
10. Full control by decision makers on all steps of the decision making process in solving a problem.
11. End users can develop and modify their own simple systems.

Modeling capabilities allow experiments with a variety of different strategies under different configurations.

F. Case Based Reasoning

Case Based Reasoning (CBR), is the process of solving new problems based on the solution of the same past problems. Case Based Reasoning (CBR) is an approach that uses old cases / experiences to understand and solve new problems. The CBR approach consists of creating basic knowledge (or databases) containing past cases (products). Defines a new case (concept), takes a case similar to a new case, and adjusts the solution from a case taken for a new case.

Case Based Reasoning (CBR) is one method for building expert systems with decision making from new cases based on solutions from previous cases. The concept of the case based reasoning method is found from the idea of using documented experiences to solve new problems. The decision makers mostly use experiences from previous problem solving to solve the problems faced now.

Case Based Reasoning (CBR) is a method used to implement computer diagnostic systems into applications in the real world. CBR can also be used to analyze a problem in accordance with the case at hand and to further classify the case based on past experience of classification.

The advantage of CBR is that it allows the use of past case examples to acquire knowledge and finally the subject matter is known. In addition CBR can also find solutions to these problems based on past case experience so that all problems can be resolved for the next case and the solution is stored to then be used again to solve a new case, if the case is almost the same or may be the same as the previous case.

CBR Cycle, as a whole the CBR Cycle model can be described by the following process:

1. RETRIEVE, is a process to get back a previous case that is similar to the case being faced.
2. REUSE, is a process to reuse information and knowledge in previous cases to solve problems encountered.
3. REVISE, is the process of fixing solutions that already existed before.
4. RETAIN, is the process of storing a new case and the solution to be used in resolving the next case

The four processes above will continue to be carried out when facing new cases. The CBR model can be presented in Figure 1 below:

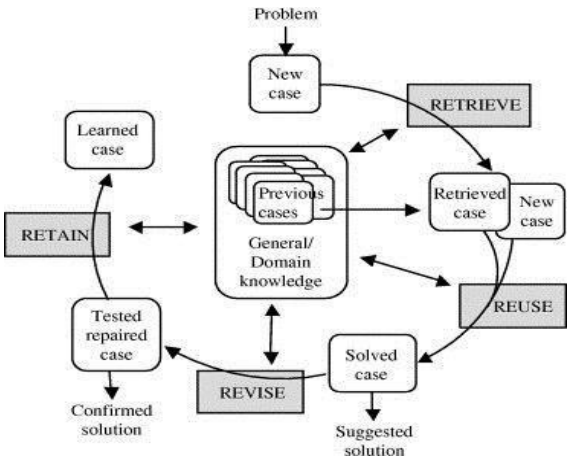

Fig. 1. CBR Model

G. **Nearest Neighbor Algorithm**
Retrieval process in case-based computer reasoning system for diagnosing pests and diseases in this rice field using the nearest neighbor algorithm.

The formula for calculating proximity between two cases is as follows:
Similarity (T,S) = Wi
Information :
T = new cases
S = cases that are in storage
N = number of attributes in each case
I = individual attributes between 1 until n
f = similarity function for I feature in case T and case S
w = the weight given to the i attribute

H. Data Flow Diagram (DFD)
Data flow diagrams describe the components of a system, data flow, and data storage. The use of DFD is to make documentation of existing systems or to compile documentation for the new system. DFD is a model making that allows system professionals to describe the system as a functional process network that is connected to each other with data flow, both manually and computerized. DFD is a diagram that is used to describe the processes that occur in the system being developed and the data involved in each process can be identified.
There are two types of symbol notation used in the data flow diagram, namely Yourdon / DeMarco Notation and Gane Sarson Notation.

I. Entity Relationship Diagram (ERD)
Entity Relationship Diagram (ERD) is a network model that uses the composition of data stored on the system in an abstract. Entity Relationship Diagram (ERD) also describes the relationship between entities that have a number of attributes with other entities in an integrated system. ERD is used by system designers to model data that will later be developed into a database. Entity Relationship Diagram (ERD) is a network model that uses the composition of data stored in the system in an abstract manner. Entity Relationship Diagram (ERD) also describes the relationship between entities that have a number of attributes with other entities in an integrated system. ERD is used by system designers to model data that will later be developed into a database.

J. PHP Programming Language
PHP is a server-side web programming language that is open source and is a script that is integrated with HTML and located on the server (server side HTML embedded scripting). An idea from a Danish C language programmer, Rasmus Lerdorf in 1995 was the beginning of the birth of the PHP programming language. PHP (Hypertext Preprocessor) is a web-based programming that has the ability to process data dynamically.

K. MySQL (My Structured Query Language)
MySQL is a database management system software (Database System) which is very popular in web programming circles. MySQL is the most popular database is used to build web applications that use the database as the source and management of the data. MySQL's popularity is possible because of its ease of use, fast query performance, and sufficient for the needs of small to medium-scale enterprise databases. MySQL is a database used by leading sites on the internet to store data (Sidik, 2005).

L. Waterfall Method
The waterfall system development method is an SDLC approach that completes the project with sequential stages. The steps in the waterfall method are system planning, needs analysis, design and implementation.

The stages in the waterfall system development method are shown in Figure 2.

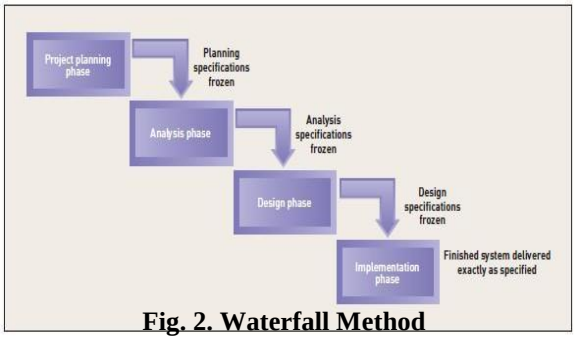

Fig. 2. Waterfall Method

III RESEARCH METHOD

This research was conducted at STMIK Pringsewu. The time of the research was conducted in the even semester of the 2017-2018 school year.

A. Observation Method
Observation in the context of scientific research is a deliberate study and carried out systematically, planned, directed at a goal by observing and recording phenomena or behavior in the group of people in the context of everyday life and paying attention to the requirements of scientific research. Therefore the results of observation can be accounted for the truth. in this case the author interviews directly with the selection team.

B. Literature Review Method

The literature review method is a data collection technique by studying references in the form of documents / files and collecting data, legislation, books, research journals, etc. Through literature review studies of legislation related to regional potential management. The need for data that reveals the indicators used by potential investors for investment decision making is obtained through literature study of books and research journals. Literature study is also conducted to determine the information technology capabilities that will be applied in the system in this case the author seeks, studies, summarizes various sources of literature related to the problem.

IV. SYSTEM DESIGN AND IMPLEMENTATION

In the initial stage is defining the problem that will be solved from the system to be built. How to solve the problem of determining the achievement of lecturers, so that the selection process can take place more quickly and accurately and minimize the occurrence of subjective and irrelevant assessments. With this problem, a decision-making plan was built to determine the STMIK Pringsewu lecturers' scholarship for Doctoral further studies using the CBR method.

A. Design Using CBR Method, namely

a. Database Structure Design

The system database structure proposed in this study is as follows:

a. Admin Table Structure

This table 1 is used to store administrator login data

Database Name : cbr
Table Name : admin
Main Key: idadmin
Storage Media : Harddisk

Table 1. Admin Table Structure Design

Field Name	Data Type	Size	Information
Idadmin*	Int	5	Admin ID
username	Varchar	32	User name
password	Varchar	32	Password
Idattribute	Int	10	Attribute

b. Attribute Table Structure

This table 2 is used to store attribute data

Database Name : cbr
Table Name : atribut
Main Key: idatribut
Guest Key : idpertanyaan
Storage Media : Harddisk

Table 2. Attribute Table Structure Design

Field Name	Data Type	Size	Information
idatribut*	Int	20	Attribute ID
Atribut	Varchar	150	Attribute
idpertanyaan**	Int	10	Question ID
Bobot	Varchar	12	Attribute Weight

c. Old Case Detail Structure

This table 3 is used to store detailed data on the properties of the old case

Database Name : cbr
Table Name : detailkasuslama
Main Key: iddetail
Guest Key :idkasus, idgejala, idatribut
Storage Media : Harddisk

Table 3. Old Case Detail Structure Table

Field Name	Data Type	Size	Information
Iddetail*	Int	10	Primary key
Idkasus**	Int	10	Old case ID
Idpertanyaan**	Int	10	Question ID
Idatribut**	Int	10	Attribute ID

d. Question Table Structure

This table 4 is used to store data on location eligibility questions to establish a community learning center

Database Name : cbr
Table Name : pertanyaan
Main Key : idpertanyaan
Guest Key : Pertanyaan
Storage Media : Harddisk

Table 4. Question Table Structure Design

Field Name	Data Type	Size	Information
Idpertanyaan*	Int	10	Question ID
Kelayakan	Varchar	100	Eligibility
Pertanyaan**	Varchar	250	Eligibility Question
Keterangan	Varchar	200	Information

e. Old Case Table Structure

This table 5 is used to store old case.

Database Name : cbr
Table Name :Kasus Lama
Main Key: idkasus
Guest Key : idkelayakan
Storage Media : Harddisk

Table 5. Old Case Table Structure Design

Field Name	Data Type	Size	Information
Idkasus*	Int	10	Old case ID
Nama	Int	100	Old case name
Idkelayakan**	Int	3	Eligibility ID

f. Proximity Table Structure

This table 6 is used to store data between symptoms

Database Name : cbr
Table Name : kedekatan
Main Key: idkedekatan
Guest Key : idpertanyaan
Storage Media : Harddisk

Table 6. Proximity Table Structure Design

Field Name	Data Type	Size	Information
Idkedekatan*	Int	10	Proximity ID
Idpertanyaan**	Int	10	Question ID
Kedekatan	Varchar	50	Proximity Value

g. Eligibility Table Design

This table 7 is used to store eligibility data for determining scholarship recipients

Database Name : cbr
Table Name : kelayakan
Main Key: idkelayakan
Guest Key : -
Storage Media : Harddisk

Table 7. Eligibility Table Structure Design

Field Name	Data Type	Size	Information
Idkelayakan*	Int	10	Eligibility ID
Kelayakan	Varchar	100	Eligibility
Keterangan	Text		Information

h. Similarity Table Structure
This table 8 is used to store data values for proximity attributes
Database Name : cbr
Table Name : similarity
Main Key: Similarity
Guest Key : idkasus, idatribut
Storage Media : Harddisk

Table 8. Similarity Table Structure Design

Field Name	Data Type	Size	Information
Idkasus**	Int	10	Old case ID
Idatribut**	Int	10	Attribute ID
Similarity	Float		Similarity Value

i. Subattribute Table Structure
This table 9 is used to store sub attribute data

Database Name : cbr
Table Name : subatribut
Main Key: idsub
Guest Key : idatribut
Storage Media : Harddisk

Table 9. Sub attribute table structure design

Field Name	Data Type	Size	Information
Idsub*	Int	10	Registration ID
Idatribut**	Int	10	Attribute ID
Idpertanyaan**	Int	10	Question ID

B. Required attributes and case study calculations
The scholarship recipient's assessment attributes for continuing Doctoral education are as shown in Table 10 and Table 11.

Table 10. Attribute code and determination

Attribute Code	Attribute Determination
A1	Age
A2	GPA
A3	Achievement
A4	Discipline
A5	Work Loyalty
A6	TOEFL score

Table 11. Variable and Weight

Variable	Weight
Appropriate/Important	1
Not appropriate/Medium	0.50 – 0.90
Very inappropriate/Not important	0.01-0.49

Sample case :

1. Data of lecturer candidate 1 for scholarship recipient is shown in Table 12.

Table 12. Data of lecturer candidate 1

Name	Attribute	Value
Adi Prastiya	Age	32 years old
	GPA	3.50
	TOEFL	480
	Discpline	Discipline
	Loyalty	Has been working for 3 years
	Achievement	Many achievements

Calculations to calculate whether the lecturer receives a scholarship or not are as follows:

$$\text{Similarity}(T, S) = \frac{S1*W1 + S2*W2 + \ldots \ldots + Sn*Wn}{W1 + W2 + \ldots \ldots + Wn}$$

$= [(1*1) + (1*1) + (1*1) + (1*1) + (1*1) + (1*1)]$
$= 1 + 1 + 1 + 1 + 1 + 1$
$= 6/6$
$= 1$

2. Data of lecturer candidate 2 for scholarship recipient is shown in table 13.

Table 13. Data of lecturer candidate 2

Name	Attribute	Value
Ade Irfan	Age	32 years old
	GPA	3
	TOEFL	440
	Discpline	Not Discipline
	Loyalty	Has been working for 1 year
	Achievement	Not adequate

$$\text{Similarity}(T, S) = \frac{S1*W1 + S2*W2 + \ldots \ldots + Sn*Wn}{W1 + W2 + \ldots \ldots + Wn}$$

$= [(1*0.3) + (1*0.5) + (1*0.5) + (1*0.5) + (1*0.5) + (1*0.6)]$
$= 0.3 + 0.5 + 0.5 + 0.5 + 0.5 + 0.6$

$= 2.9/6$
$= 0.48$

Table of results of the calculation of scholarship determination is shown in table 14.

Table 14. Final result

Name	Total	Information
Adi prastiya	1	Proper
Ade irfan	0.48	Not Proper

C.Display Design

a. Indeks Page

The index menu is the start page of the program. On this page there is a home menu, identification, and login. The index page is created with an attractive design and select menus which make the user easy to use. Can be seen in Figure 3 below.

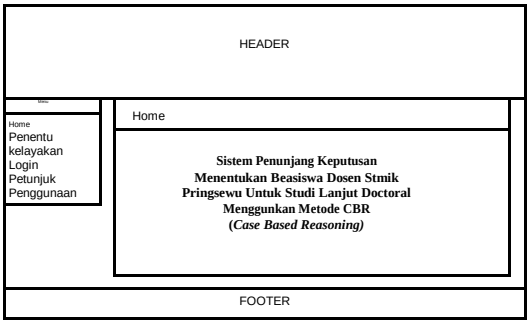

Fig. 3. Index Page Display Design

b. Data Criteria Page

This page contains criteria for scholarship recipients. Can be seen in Figure 4 below.

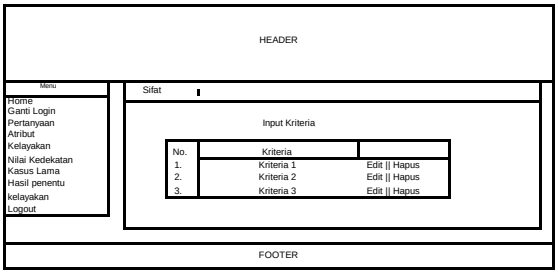

Fig. 4. Criteria for scholarship recipients design

c. Question Page

This page contains a list of questions. On this page there is a menu, input questions, edit questions, and delete questions. Can be seen in Figure 5 below.

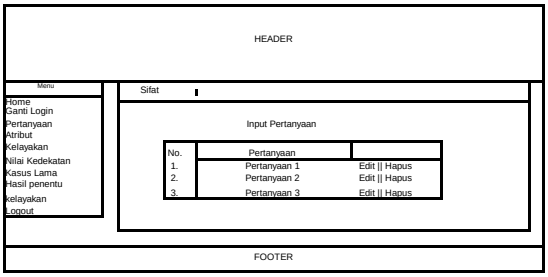

Fig. 5. Question List Display Design

D. Implementation

The results obtained from the Decision Support System using the CBR method are the existence of a program that can be used to assist in the decision making of scholarship recipients. This system consists of several modules such as reports as a means to display data in the form of reports, and other data files. Figure 6 shows homepage. Figure 7 shows determination of scholarship recipients page. Figure 8 shows form for determination of scholarship recipients page. Figure 9 shows final result.

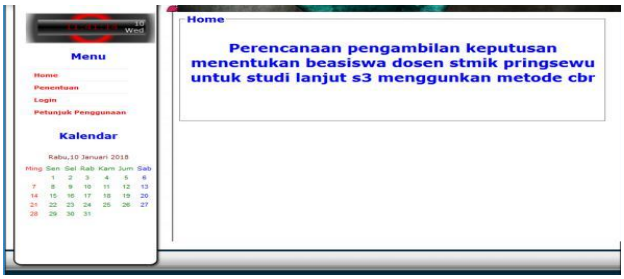

Fig. 6. Homepage

Fig. 7. Determination of scholarship recipients

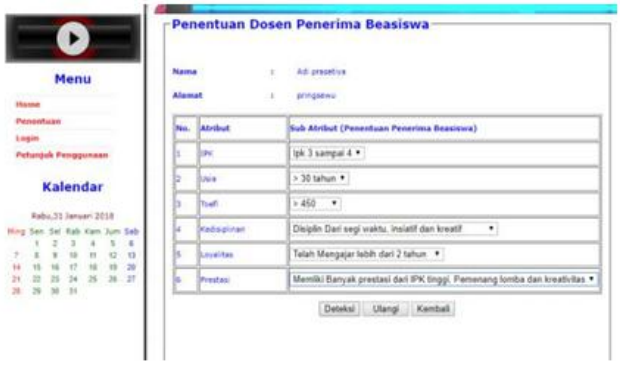

Fig. 8. Form for determination of scholarship recipients

Fig. 9. Final Result

V. CONCLUSION AND SUGGESTION

A. Conclusion

From the discussion above can be concluded that:

1. Decision support systems built with the CBR method can replace manual processes that are still running and can help quickly in determining decision making.
2. With this system the scholarship recipient's assessment will be much faster and more accurate.

B. Suggestion

To select scholarship recipients and improve the decision support system that has been made, the researcher gives the following suggestions:

1. The system is built so that it can be utilized to the maximum extent possible.
2. The system built is expected to improve the existing system.
3. As a reference for the use of other methods.

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