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Designing Decision Support System for Midwifery Students' Tuition Fees Problem

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ABSTRACT

Education is an essential need and an important element to create a broad-minded youth. While in Indonesia, the rate of tuition fees is still imbalanced with the economic rate. Thus, many people decided to discontinue their higher education. Decision making plays an important role to manage organizations, including in educational institutions, as one of the main duties in managerial is making decisions. This study took place in a midwifery academy in Malang. In response to this situation, the academy has a policy to alleviate students by paying the tuition fees in instalments. However, many students are in arrears as the result of this policy. Thus, management needs to take some consideration before making a decision toward the problem. Those considerations require high accuracy and time consuming to process information that support decision making. Currently, the decision-making process in this academy is still semi-automated, in which some processes are still done manually, which affect longer time to make decisions, and the accuracy of calculations could not be fully guaranteed. According to this condition, the purpose of this research is to design a decision support system that enables us to process information for decision making and to offer decision alternatives for decision makers. This research employs *Systems Development Life Cycle (SDLC)* with a decision table as a method to create decision alternatives. The prototype was developed using Visual Studio C#.Net. The result shows that by using the proposed prototype of DSS, decision makers can reduce 5-10 minutes of decision making process compared to the old semi-automated system which still required manual calculation and data collection and analysis before making the decision. A complete data and more detailed parameters for decision criteria are required to implement the proposed prototype of DSS in the institution with more objective consideration in the decision making process as the future work.

1. Introduction

Education plays an important role in forming the future generations with quality and broad insights for the country and the nation. It is also one of the most important things of human needs. However, the tuition fee nowadays is pricey, especially for tertiary education. Many individuals choose to take vocational education and training on the grounds of its accessibility, affordability, and variety of opportunities for both middle and high skilled jobs [1][2]. Yet, even some of them prefer not to continue their education. Midwifery academy becomes one of alternative options for higher education in the health sector [3], for example in our case study, the XYZ Midwifery Academy (later abbreviated as XYZ MA) in Malang.

The large number of students certainly do not imply that all of them have well-established economic backgrounds. Some of them struggle to survive from the obligation to pay tuition fees due to their parent's modest income [4][5]. Data from XYZ MA that are obtained and used in this study are related to students' payment records and their academic records from students in class of 2008 to class of 2011. It shows that the most number of students in arrears are students from the class of 2010. Around 34.12% of them are in arrears, followed by around 25.18% of students in class of 2008, around 15.63% are from students in the class of 2009, while the students in class of 2011 was around 10, 94%. This made XYZ MA management have to be more flexible in dealing with the problem of student educational costs. However, the management's policy in making students able to pay their tuition fees with instalments caused another problem, namely a large number of students who were in arrears for their tuition fees. Consequently, the decision-making process regarding the issue of tuition fees at XYZ MA is currently not effective and inefficient.

According to [6][7][8], educational decision-making based on data often involves massive data processing, which must be aided by information systems. Most educational institutions use computers to support their work related to accounting, personnel, registration, academic records, inventory management and library systems. However, the impact of computers in university administration has been less impressive [9][10][11]. For instance, in our case study, XYZ MA is still lacking in the use of information technology to integrate information from students' payment data records, academic records, and other information that are required to support their managerial decision making, such as to make decisions related to students' tuition fee problems. Another DSS program development for education, especially to support teachers in identifying students' ability through finding appropriate learning style (LS) for them to indirectly improve their achievements and to create effectiveness in learning activities [8][12].

Decision support systems (DSS) are interactive information systems that provide information, modelling, and data manipulation. The system is used to assist semi-structured decision making or even unstructured situations in which no one knows how decisions should be made exactly [13]. DSS has three main components, namely the database subsystem, the model base subsystem, and the user interface subsystem. For a decision support system that involves various criteria, the model base subsystem can be designed using a decision table. The decision table is a suitable method for making qualitative decisions based on multicriteria. It describes a complex condition that can be used as a tool in the process of making decisions [14].

Currently, the decision-making process in this academy is still semi-automated, in which some processes are still done manually, which affect longer time to make decisions, and the accuracy of calculations could not be fully guaranteed. By considering to utilize technology that is currently developed in the academy, a decision support system is required to support the decision-making process accordingly with policies from the XYZ MA management related to this issue.

Some problems can be identified according to the aforementioned background, such as:

1. Most of the students at XYZ MA, especially the final year students, are in arrears for their tuition fees.
2. The management of XYZ MA often finds it difficult to identify transaction files of the delinquent students as a source of information to support decision-making.
3. The current information system applied in XYZ MA has not been integrated with any source of information that is required to support the decision-making process.
4. The existing accounting information system is only able to calculate and record students' payment records, and record them all in a ledger journal.
5. There is no decision support system in XYZ MA that can provide required information as well as display decision alternatives for supporting the management decision making process regarding the issue.

Based on those problem identification, the purpose of this study is to find about what kind of decision support system that should be developed, in order to provide information and to offer alternative decisions, towards policies related to tuition fees problems, that support management in XYZ MA in making a wise decision for their students. Therefore, the aim of this study are:

1. Designing the database that stores related information to access information sources in the decision support system in XYZ MA.
2. Designing several existing systems so that they can be integrated into a source of decision support information.
3. Designing a decision model that is able to support the determination of alternative decisions identified from the critical categories of students.
4. Produce a prototype of a decision support system that can provide some important information, such as: the amount of arrears, duration of arrears, and its critical categories as supporting information to make decisions more quickly, precisely and accurately.

Regarding the background discussed above, a study is needed to make a decision support system more effective and efficient to use by using the decision table method. This prototype of decision support system is expected to be able to help XYZ MA management in determining policies for students' tuition fee problem more easily, quickly and accurately in accordance with the procedures and criteria set by the management.

2. Literature Review

Referring to [9], it is mentioned that the decision support system is initiated by the traditional management information system because it can support users in making decisions in various stages, even though the final decision remains in the hands of the decision maker. As the aforementioned, a decision support system consists of three main components or subsystems and one optional subsystem, namely [13][15][16]:

1. Data management subsystem (database)

The database subsystem is a component in the DSS that functions as a provider of relevant data for a situation and is managed and stored in the Database Management System (DBMS) so that it can be retrieved and extracted quickly.

2. Model management subsystem (model base)

Model base subsystem is the system's ability to integrate data with decision models. The model base subsystem is a model that is able to assist the data analysis process and conditions to be able to provide multi-criteria decision support information

3. User interface subsystem (user interface)

User interface subsystem is a dialog system that can be interpreted and implemented, so that users or users can communicate with the system that is designed.

4. Knowledge based management subsystem (knowledge based)

This knowledge-based subsystem supports all other subsystems or acts directly as an independent and optional component.

Some related studies develop DSS for education or academic related issues. DSS was developed by [12] to support teachers in identifying students' ability through finding appropriate learning style (LS) for them. Optimization-based DSS was studied by [17] to facilitate academic advising by means of optimal long-term course planning. In addition, [18] developed interactive DSS to support academic advising by providing careful planning for different courses over several semesters according to students' preferences and goals with consideration of student constraints and administrative regulations.

Regarding decision tables, a quotation taken from [19] implies that a decision table is used to express a logical structure which presents all possible combinations of conditions that might occur along with the actions that follow. Decision table is a table that describes a complex condition that can be used as a tool in decision making. This decision table has a structure consisting of columns and rows having 4 quadrants as seen in Fig. 1.

Condition and Action	Rules
Condition	Condition Alternatives
Action	Action Entries

Fig. 1– The Four Quadrant of Decision Table

In making a decision table, it is necessary for an analyst to eliminate some impossible, inconsistent, or repetitive conditions to make the decision table as simple as possible, and also define the maximum size of the table. Some research studies employed decision tables as their method to model complex rule sets in water management [20], reducing complex rules for software development testing [21] and supporting management processes in mining companies [22] which are related to decision making. Thus, this study aims to develop a prototype of DSS to support the decision-making process for midwifery students' tuition fee problems using decision table method which enables the determination of multicriteria alternative decisions in developing the prototype.

3. Methodology

In this section the systematic steps of how the research be carried out, such as DSS analysis and design phase detailed process, namely the SDLC (System Development Life Cycle) stage, is explained through the flow diagram shown in Fig. 2.

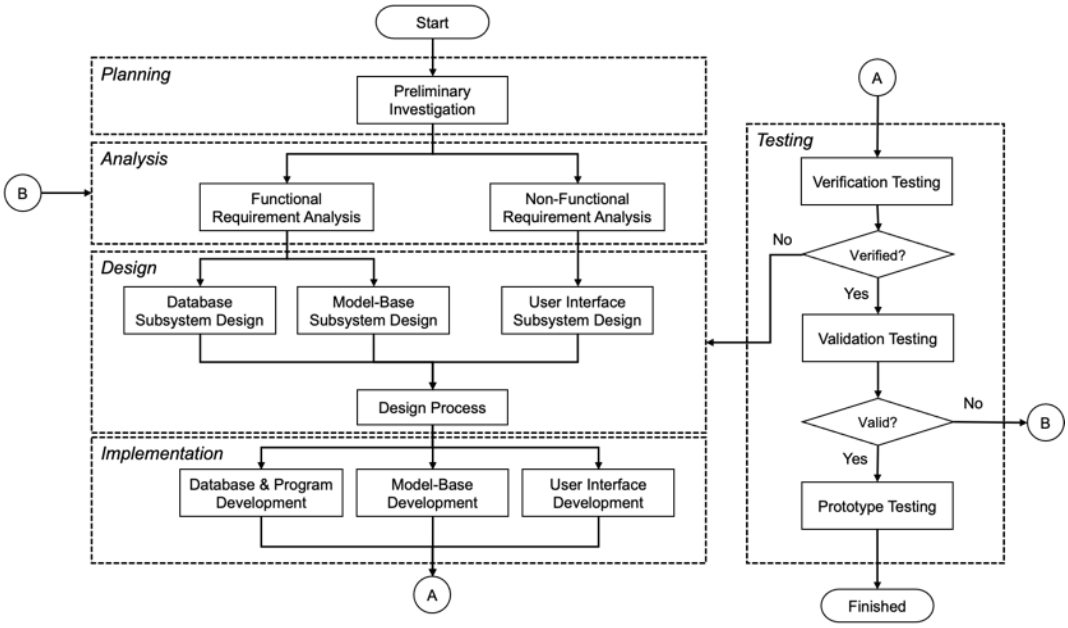

Fig. 2 – DSS Development Framework

This stage is the core stage of this research. In carrying out system analysis and design, there are separate systematic stages that need to be carried out based on SDLC [23][24][25][26], namely:

a. *Planning*

This stage is carried out in order to obtain optimal results. At this stage, the steps required are identifying the problem, identifying the target of the system to be developed, defining the project scope, and documenting the results. Through these steps, it is expected that the designed system can be developed according to the specifications and needs of the user in solving the problem. In this study, the planning stage is carried out by identifying the user's needs for a new system (decision support system), determining data and models required, determining criteria that can support the design of new procedures and systems, what approaches will be used and other requirements to create a decision support system design framework.

b. *Analysis*

This is a stage where the current system will be learned and analyzed before proposing a new system development. System analysis is carried out to help determine user needs into a new system design which will be implemented into an application program. The main objective of the analysis phase is to understand business requirements and process requirements of the new system. At this stage, the reasons behind the previous stage are then analyzed. Regarding user needs that are generally found from the interview results are grouped into functional and non-functional requirements. After knowing the user needs both functional and non-functional, then we need to determine what method is suitable to be employed as a problem-solving tool.

c. *Design*

In this stage, the complete system specifications are made based on the needs recommended in the previous stage. The three main components of the DSS are formulated as well in this stage, to meet the functional needs of the user, such as:

1) The database subsystem will later contain data taken from current information systems running in XYZ MA, especially regarding students' academic records, administration and students' payment records of students from 2008-2011. In this component, the steps taken include:

a) Creating an Entity Relationship Diagram (ERD), which is a graphical model that describes the relationships between entities in a system.

b) Making Data Flow Diagrams (DFD), which is a diagram that describes how data flows in an information system.

2) Model base subsystem is the system's ability to integrate data with decision models. The employed method to form the model-base subsystem is a decision table which is suitable for obtaining decision alternatives from a multicriteria condition. Decision alternatives will be derived in an algorithmic manner based on the information that is contained in the tables. This method is basically can be employed at all stages of the information systems design process as they pass on the logic of eliminating redundant information, and provide accuracy, and facilitate the process during programming [21][22][27]
3) User interface subsystem is a dialog system that can be interpreted and implemented, so that the user can communicate with the designed system.

In addition, the design process will embody the requirements into a software design before the program is developed. Data structures, software architecture, interface representations, and procedural details (algorithms) will be the main focus of this process. Designing system certainly includes three parts, namely:

1) *Input design*, which is a design that contains any data that becomes input in this study. The input design is a manual design or a design that is taken based on the data flow.
2) *Process design*, which is a design that contains any procedures that must be executed to convert input into output. In this study, the process design was created by changing the data that was entered into the DFD data stream into pseudocode.
3) *Output design*, which is a design that contains what information will be the output. In this research, the output design is a pseudocode which represents the decision table into a decision library containing decision alternatives that can support the decision maker.

The design stage usually produces several documents, including data model, process model, table designs, hierarchies between modules, to the interface design of the system to be created. The user interface design at this stage is made to meet the non-functional requirements of the user.

d. *Implementation*

The implementation of all design results in the previous stage is made into a computer-based application program. In this decision support system engineering, program implementation is carried out by creating a database based on the ERD that has been made, implementing pseudocode into program code, and creating a user interface or menu design.

e. *Testing*

The testing process consists of verification, validation, and prototype testing. These three processes are carried out to ascertain whether the whole system is running as expected. Verification test aims to check whether the translation of the conceptual model into a computer program is carried out correctly. Validation test determines whether the program created is able to represent the design objectives. Test the prototype aims to test whether the prototype made is in accordance with user requirements.

4. System Development Result and Discussion

4.1. Planning

In this part, a preliminary investigation was done based on the results of observations in terms of interview and direct brainstorming with XYZ MA management. The result can be seen that the process of identifying students' tuition fee problems was still done manually. There is no automation system that can facilitate the information about the list of students who are in arrears and support the decision-making process. Therefore, the identification and decision-making process takes a long time because in making decisions for these issues, payment records, academic records, and financial data are required. That information basically has been available in the current system, yet has not been integrated into its own decision support system. The decision support system (namely DSS-XYZ MA) will be developed based on the several criteria and policies set by the management of XYZ MA, along with alternatives that may be chosen to solve the students' tuition fee problem of XYZ MA so that the decision-making process is more effective and efficient.

4.2. Analysis

4.2.1. Functional Requirements Analysis

Functional requirements are directly related to a process that must be carried out by the system or information that must exist in the system. Functional requirements usually indicate what facilities are needed and what activities

are happening in the new system. Looking at this statement, the functional requirements of a decision support system on the students' tuition fee problem can be described as follows:

1. The system allows the director to obtain decision support information in the form of financial records, administrative data, and academic records, which are the main parameters to make decisions and determine the critical category of each student's in arrears.
2. The system allows the director to obtain information about the critical category of each student's in arrears (red: very critical, yellow: critical, or green: non-critical) in terms of academic records and financial records
3. The system allows the director to get decision alternatives to support management's decision making for the critical category of each student's arrears in XYZ MA, more easily, quickly, and accurately.

4.2.2. Non-Functional Requirements Analysis

Non-functional requirements refer to the behavioral attributes a system must have, such as performance and useability. This non-functional requirement is viewed from an operational, security, information, and performance point of view.

1. Operational

Operational and non-functional requirements explain how the system operates, and what software is used.

a. Existing systems running at XYZ MA: Accounting Information Systems, Academic Information Systems, and Administrative Information Systems.
b. The decision support system was developed using Ms. Visual Studio 2008 software.
c. The database server used is MySql Server 5.5.17.

2. Security

There is no password system to maintain convenience and security for users to enter into decision support system applications and use them. This is because only the director has this application and is entitled to use it.

3. Information

Information is stored in several separate view tables to access the required data and is obtained from the accounting, academic, and administrative information systems that already exist in XYZ MA.

4. Performance

Performance can be seen from the ability of data to remain secure and accessible by integrating several existing database components. Hence, it is expected that users can easily access data in a fast and more precise time.

4.3. Design

4.3.1. Database Subsystem Design

Data modelling is a way to describe the data used and developed in a business system. The method that is usually taken as a form of data modelling is by creating an ERD (Entity Relationship Diagram). The ERD of the XYZ MA decision support system can be seen in Fig. 3.

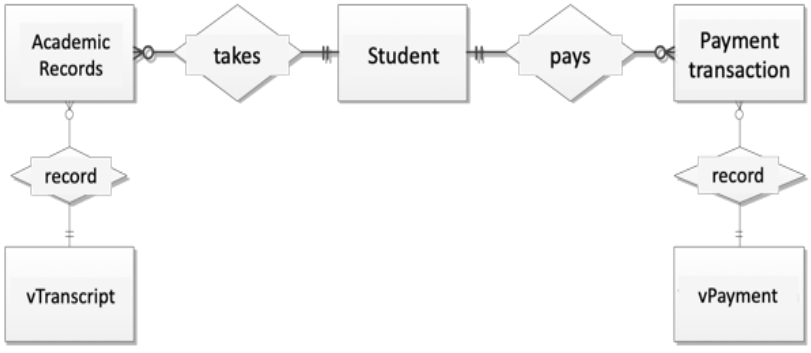

Fig. 3 – ERD of XYZ MA

After that, the physical database design stage is carried out after the creation of the ERD. The physical database design that is made is in the form of a view table as a source of decision support information in the DSS for XYZ Midwifery Academy as shown in Table 1 for an example.

Tabel 1 – View Payment Records

Field	*Type*
NRM	Varchar(12)
NAMAM	Varchar(60)
SPP*	Decimal (32,0)
REG	Decimal (32,0)
MHS	Decimal (32,0)
PRK	Decimal (32,0)
UJS	Decimal (32,0)
TuitionPayment	Decimal (32,0)
SWP*	Decimal (32,0)

* *SWP = Donations Compulsory Education*
SPP = Tuition Fee

Process modeling is carried out by making DFD which aims to describe how business processes operates, to illustrate the activities carried out and to show how data moves between these activities.

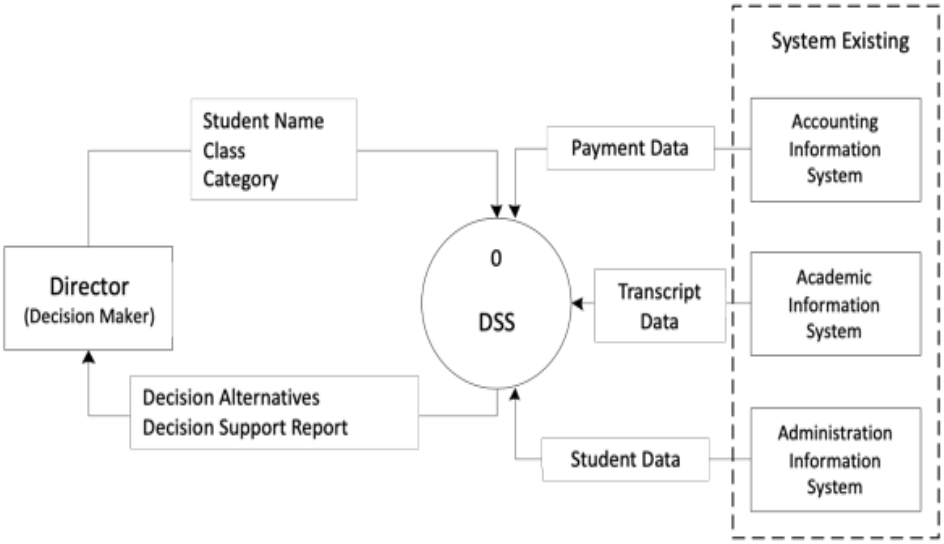

Fig. 4 – Context Diagram DSS-XYZ Midwifery Academy

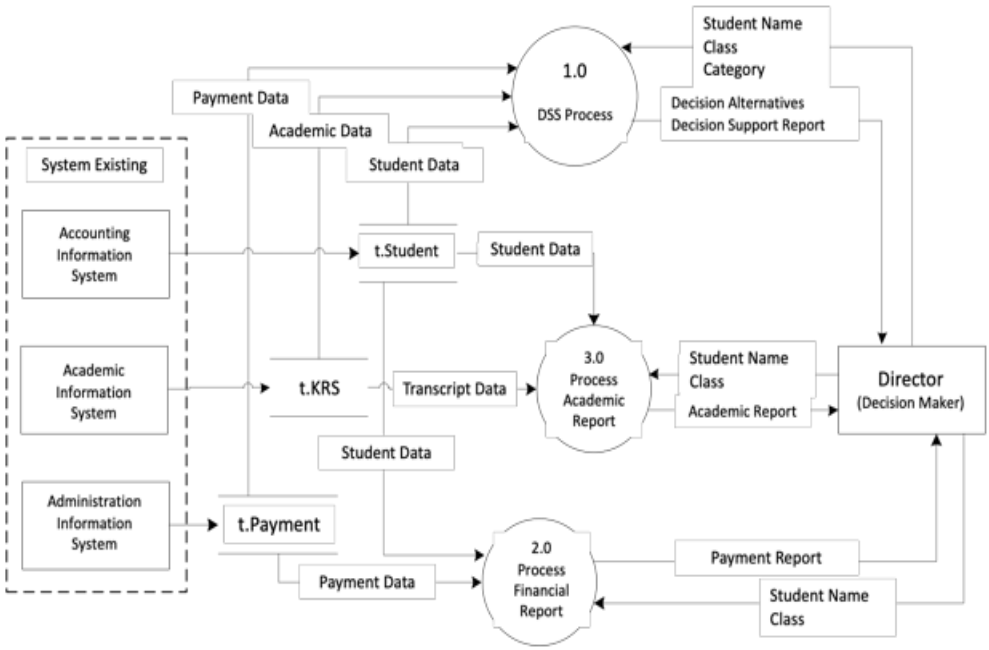

Fig. 5 – DFD Level 1 from Level 0 of DSS

The context diagram as shown in Fig. 4 is further broken down into DFD Level 1 in detail which is shown in Fig. 5.

4.3.2. Model Base Subsystem Design

In the development of the decision support system of this study, there are two parameters for determining alternative decisions, namely students' payment history and academic evaluation. Some mathematical models were constructed to support the rules extraction during the design of decision table. All of the calculations and parameter presented in this section are constructed in accordance with the process business at XYZ MA and were obtained through intensive interview with the director, who plays a role as a decision maker of the institution. Those are presented as follows:

In this case, decision alternatives may vary in terms of students' payment history which consists of several parameter, such as:

1. Tuition fee for each semester

$$tf = \frac{1}{6} \times TF \tag{1}$$

Where:

tf = tuition fee allocation in each semester
TF = total tuition fees until graduate (6 semesters)

2. Detail component of tuition fee for each semester

$$F_s = tf_s + rf_s + sf_s + pf_s + ef_s \tag{2}$$

Where:

F_s = detailed tuition fee in each semester
tf_s =tuition fees for semester s
rf_s =registration fee for semester s
sf_s = student affairs fee for semester s
pf_s = practical fee for semester s
ef_s = exam fees for semester s

3. Total of all paid tuition fees

$$pF = \sum_{s=1}^{ts} F_s, \text{ where } s = 1,2, \dots, ts \quad (3)$$

Where:

pF = total of all paid tuition fees
ts = total semesters until graduate (pre-defined as 6 semesters)
s = current active semester

4. Total current billing should be paid

$$cB = \frac{s}{ts} \times TF \quad (4)$$

Where:

cB = current billing should be paid

Based on those mathematical model calculations, the determination of critical status in terms of tuition payment for the corresponding student can be defined as follows:

$$critical\_status_{payment} \begin{cases} cB - pF = 0 & non - critical\ (green) \\ 0 < cB - pF \leq tf_s & critical\ (ellow\ ) \\ cB - pF > tf_s & very\ critical\ (red) \end{cases} \quad (5)$$

where:

1. Non-critical status (green) appears if the current billing should be paid - the total of all paid total fees = 0, then the student is not in arrears.
2. If the current billing should be paid - the total of all paid total fees are between 0 and the tuition fee each semester (0 < arrears ≤ tuition fee each semester), then the student is declared to be in arrears for 1 semester.
3. If the total tuition fee should be paid - the total fees > the tuition fee each semester, then the student is declared to be in arrears for 2 semesters or more.

In addition, there is a compulsory education donation (SWP) that students need to pay as well. If the SWP has not fully been paid yet, then it will be considered as very critical, and thus marked in red color on the decision table. Furthermore, in terms of academic history, some mathematical formulations to calculate GPA and percentage of grade E, D, and D+, according to students' academic transcript, were constructed as the following.

1. GPA calculation

$$GPA = \frac{\sum_{i=1}^{n} C_i \times wG_i}{\sum_{i=1}^{n} C_i} \quad (6)$$

Where:

GPA = grade point average
C_i = total credits of subject i
wG_i = weighted grade of course subject i
i = index of course subject, where $i = 1, 2, \dots, n$
n = total number of course subject in the transcript

2. Percentage of grade E, D, and D+

$$pE = \frac{\sum_{e=1}^{m} C_e}{\sum_{i=1}^{n} C_i} \quad (7)$$

Where:

pE = percentage of grade E in the transcript
C_e = total credit of course subject with grade E in the transcript, where $e = 1, 2, \dots, m$
e = index of course subject with grade E in the transcript, where $e = 1, 2, \dots, m$
m = total number of course subject with grade E in the transcript
C_i = total credits of subject i in the transcript, where $i = 1, 2, \dots, n$

Table 2 – Decision Table in Terms of Tuition Payment History

	Conditions	Rules					
		1	2	3	4	5	6
Conditions	Paid SPP						
	Paid SWP						
	Decision Alternatives						
Result Condition	Red: Very Critical	v		v			
	Yellow: Critical		v		v	v	
	Green: Non-Critical						v
Actions	Allow tuition waivers	v	v	v	v	v	
	Allow Extension Payment Due	v	v	v	v	v	
	Drop Out	v		v			
	Not Eligible to attempt mid-term exam	v	v	v	v	v	
	Not Eligible to graduate	v	v	v	v	v	
	Not Eligible to take diploma	v	v	v	v	v	
	No penalty						v

Tabel 3 – Decision Table from Student Academic Aspect

	Conditions	Rules											
		1	2	3	4	5	6	7	8	9	10	11	12
Conditions	GPA												
	Total Credits with Grade of E	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
	Total Credit with Grade of D+,D	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes	No	No
	Decision Alternatives												
Result Condition	Red: Very Critical	v	v	v		v							
	Yellow: Critical				v		v	v		v	v	v	
	Green: Non-Critical								v				v
Actions	Grant Scholarship				v		v	v	v	v	v	v	v
	Retake the Corresponding Courses	v	v	v	v	v	v	v		v	v	v	
	Do Additional Assignment	v	v	v	v	v	v	v		v	v	v	
	Not Eligible to do oral exam	v	v	v	v	v	v	v		v	v	v	
	No penalty								v				v

Note that GPA is considered as very critical if the value is below 2.0; critical between 2.0 and 3.0; and non-critical if the value is greater or equal to 3.0. On the other hand, if we follow Equation 7 and students' academic transcript shows grade E more than 5% and grade D or D+ more than 15%, then those are considered as very critical, otherwise those are non-critical. Therefore, at this stage, a decision table is designed, which will help determine alternative decisions that can be taken by management before applying it to real application programs. There are 2 decision tables (DT) which are designed based on the previous calculation model, namely DT in terms of payment history and DT from the perspective of academic history as depicted in Table 2 and Table 3, respectively.

4.3.3. User Interface Subsystem Design

In this stage, we do a dialog system design that can be interpreted and implemented, thus the user can communicate with the designed system. This stage is described in hierarchical form to facilitate the user interface design of the system later. The design of the decision support system menu has two main menus, such as the DSS menu and the reports menu that contains financial report and academic report. Based on this menu, it can be explained that a user, who in this case is a director of XYZ MA as a decision maker, will have access to choose which menu to run. Fig. 6 shows the design of the display for the DSS form that will be created.

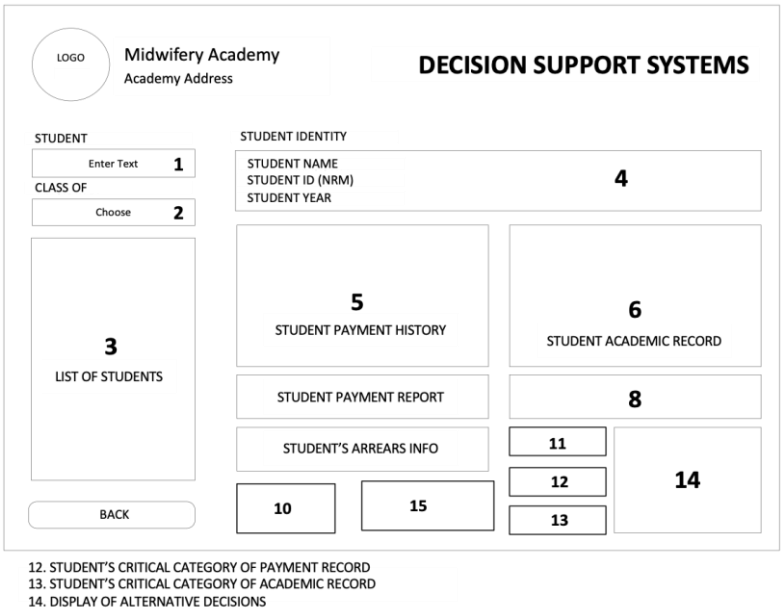

Fig. 6 – Display of Decision Support System Form

```
Program decision alternatives in terms of payment
Declare:
NRM: integer
Name: string
critical: string
Algorithm:
read(NRM or NAME)
if critical = red then
dec_alternatives_payment  Allow tuition waivers
OR Allow Extension Payment Due OR Drop Out OR Not Eligible to attempt
mid-term exam OR Not Eligible to graduate OR Not Eligible to take
diploma
elseif critical = yellow then
dec_alternatives_payment  Allow tuition waivers
OR Allow Extension Payment Due
OR Not Eligible to attempt mid-term exam OR Not Eligible to graduate OR
Not Eligible to take diploma
else
dec_alternatives_payment  No Penalty
end if
write(dec_alternatives_cost)
```

Fig. 7 – Pseudocode of Alternative Decisions According to Atudents' Critical Condition

4.3.4. Design Process

The design process will embody the requirements into a software design before developing the DSS program. Process design can be described in pseudocode or flowchart form. Pseudocode will make it easier for programmers to understand because it is similar to actual program code. The examples of pseudocode for this study is shown in Fig. 7.

4.4. Implementation

4.4.1. Database Subsystem Development

The development of a database subsystem for the prototype of the decision support system in this study was created to show the relationships between the tables used in the decision support systems in this study. The view

table is made to facilitate the provision of information required by the decision maker in making decisions for students' tuition fee problems in XYZ Midwifery Academy.

4.4.2. Development of Model Base Subsystems

The development of the model base subsystem is described by means of a programming language that implements the models that have been designed in the previous design stage. The software used for this model base subsystem is Microsoft Visual Studio 2008. This stage is the development stage of designing a mathematical model in the previous stage which is represented in the form of program code. From the mathematical calculation model for tuition fees (SPP) and compulsory education donations (SWP), an example of the syntax can be seen in Fig. 8 (A). Whereas, for the model base from a decision table, the syntax can be seen in Fig. 8 (B).

```
//Kewajiban bayar SPP sampai semester maksimum
lblWajibSPPSemester.Text = "" + ((Convert.ToDouble(lblSemester.Text) / _
                           Convert.ToDouble(lblMaxSemester.Text)) *_
                           Convert.ToDouble(lblTotalSPP.Text));
int WajibSPP = Convert.ToInt32(lblWajibSPPSemester.Text);
//kelunasan biaya pendidikan (SPP)
lblSisaSPP.Text = "" + (Convert.ToDouble(lblWajibSPPSemester.Text) - _
                  Convert.ToDouble(lblBayarSPP.Text));
//kelunasan biaya SWP
if (this.lblGelombang.Text == "0")
        {
            lblTotalSWP.Text = "4000000";
        }
else if (this.lblGelombang.Text == "1")
        {
            lblTotalSWP.Text = "6000000";
        }
else
        {
            lblTotalSWP.Text = "7500000";
        }
lblSisaSWP.Text = "" + (Convert.ToDouble(lblTotalSWP.Text) - _
                  Convert.ToDouble(lblBayarSWP.Text));
```

(A)

```
//menampilkan alternatif keputusan dari segi biaya pendidikan
        private void Keputusan_Biaya()
        {
            string decision1 = "Pemberian Keringanan Biaya Pendidikan";
            string decision2 = "Penundaan/ Perpanjangan Batas Waktu
                                Pembayaran";
            string decision3 = "Pemberhentian Mahasiswa (Drop Out)";
            string decision4 = "Tidak Diizinkan UTS/UAS";
            string decision5 = "Tidak Diizinkan Wisuda";
            string decision6 = "Tidak Diizinkan Mengambil Ijazah";
            string decision7 = "Tidak Ada Keputusan";

            if (lblKategoriBiaya_SPK.Text == "HIJAU")
            {
                lboxKeputusanBiaya.Items.Add(decision7);
            }
            else if (lblKategoriBiaya_SPK.Text == "KUNING")
            {
                lboxKeputusanBiaya.Items.Add(decision4);
                lboxKeputusanBiaya.Items.Add(decision5);
                lboxKeputusanBiaya.Items.Add(decision6);
            }
            else if (lblKategoriBiaya_SPK.Text == "MERAH")
            {
                lboxKeputusanBiaya.Items.Add(decision1);
                lboxKeputusanBiaya.Items.Add(decision2);
                lboxKeputusanBiaya.Items.Add(decision3);
                lboxKeputusanBiaya.Items.Add(decision4);
                lboxKeputusanBiaya.Items.Add(decision5);
                lboxKeputusanBiaya.Items.Add(decision6);
            }
            else if (lblKategoriBiaya_SPK.Text == "")
            {
                lboxKeputusanBiaya.Items.Add("");
            }
        }
```

(B)

Fig. 8 – Syntax for Calculating SPP and SWP (A) and The Alternative Decisions in Terms of Financial (B)

4.4.3. User Interface Subsystem Development

As the aforementioned at the design stage, the user interface subsystem was designed and developed to serve as suggestions for users to communicate and interact with the developed system. The following is an example display of the main form of Decision Support System, as shown in Fig. 9.

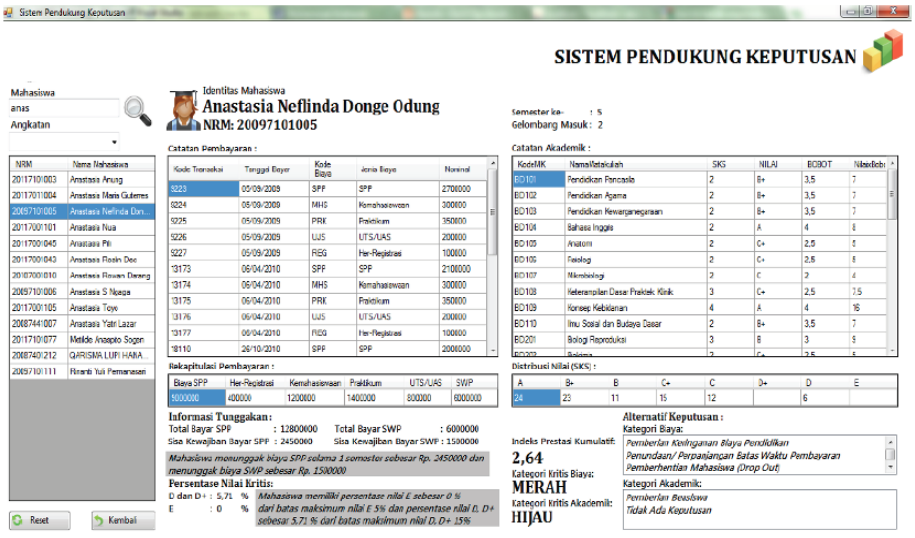

Fig. 9 – Display of The Main DSS Form

4.5. Testing

A verification test is conducted to determine whether they run as intended and meet user and customer needs. It is basically a process to ensure whether the develop prototype is run correctly and properly. Whereas, the validation test is a testing phase that aims to see or check whether the developed program or prototype is enabled to produce alternative decisions to represent the objectives of designing this decision support system based on users requirements.

This comparison process is carried out in order to determine the continuity between the model-base design, pseudocode, and program listing, when the program is run. From the verification results, it can be concluded that the prototype of the decision support system has been performed and is in accordance with the conceptual design that has been done previously. In this stage, the model-base presented in pseudocode (for instance see Fig. 7 in Section 4.3.4) was compared with the listing program (see Fig. 8 in Section 4.4.2 (B)) to see the consistency of logic between the algorithm and the system development. The model base subsystem which contains the calculation process in terms of financial and academic then becomes a reference for the logic of calculations in the system development process (see Section 4.3.2). For instance, the pseudocode in Fig. 7 represents the calculation of student's total payment of tuition fees and duration of arrears so far as well as how the result shows after running the listing program (code) as validation process. A student's information, named Anastasia Neflinda Donge with student ID number (NRM) 20097101005, was derived from the given database. The manual calculation (old system) and its comparison with the output from the proposed prototype depicted in Fig. 10.

Furthermore, the results of manual calculations or using the program produced the same values and decisions yet the proposed prototype DSS could give a more precise value of GPA and percentage of grade E, D, and D+. Thus, it can also be said that the development of this decision support system has been able to represent the design objectives, namely to provide alternative decisions that may be taken by the decision maker to support their decision-making process more quickly. This test also describes the advantages of the new system when compared to the old system. The result shows evidence that the engineering decision support system made is able to accelerate the calculation process and the determination of alternative decisions. As depicted in Fig. 10, the completion time using the proposed prototype DSS could reduce decision-making significantly, from 6-10 minutes of manual document analysis and calculation of the required data information to 15-20 seconds using the prototype. In addition, we could see that the decision table method enabled the determination of multicriteria alternative decisions in developing the prototype.

Hence, the system allows users to make decisions with quicker, easier, and more precise results than just relying on the old system. Additionally, it is also supported by the user interface that is user friendly because it is easy to use and understand by the user, accompanied by assistance just in case users are having difficulties to use the program.

	RESULT COMPARISON					
			SEMI-MANUAL (OLD SYSTEM)			PROTOTYPE (THE PROPOSED SYSTEM)
(a)	Student Name	:	Anastasia Neflinda Donge Odung			Anastasia Neflinda Donge Odung
(b)	Student ID (NRM)	:	20097101005			20097101005
(c)	Current Semester	:	5			5
(d)	Total Semester to Graduate	:	6	*pre-defined by the institution*		6
(e)	Batch	:	2			2
(f)	Compulsory Education Donations (SWP)	:	IDR 7500000.00	*based on (e) pre-defined by the institution*		IDR 7500000.00
	TUITION BILLING STATUS					
(g)	Total Bill	:	IDR 18300000.00	*pre-defined by the institution*		IDR 18300000.00
(h)	Current Billing (((c)/(d))×(g))	:	IDR 15250000.00			IDR 15250000.00
	MANUAL CALCULATION					
	Student Payment History (up to current semester):					
(i)	Tuition Fee (SPP)	:	IDR 9000000.00	*pre-defined by the institution*		IDR 9000000.00
(j)	Re-Registration	:	IDR 400000.00	*pre-defined by the institution*		IDR 400000.00
(k)	Student Affairs	:	IDR 1200000.00	*pre-defined by the institution*		IDR 1200000.00
(l)	Practical Class	:	IDR 1400000.00	*pre-defined by the institution*		IDR 1400000.00
(m)	Mid-term/Final Exam	:	IDR 800000.00	*pre-defined by the institution*		IDR 800000.00
(n)	Total Tuition Fee (paid)	:	IDR 12800000.00			IDR 12800000.00
(o)	Total Tuition Fee (unpaid) ((h)-(n))	:	IDR 2450000.00	*critical*		IDR 2450000.00 *critical*
(p)	Total Compulsory Education Donations (paid)	:	IDR 6000000.00			IDR 6000000.00
(q)	Total Compulsory Education Donations (unpaid) ((f)-(p))	:	IDR 1500000.00	*very critical*		IDR 1500000.00 *very critical*
(r)	Critical status based on (o) and (q)	:	*very critical*			*very critical*
	Student Academic History (up to current semester):					
(s)	Total Credits	:	105	*based on document of academic transcript*		105
(t)	Total Weighted Grades	:	277	*based on document of academic transcript*		277
(u)	Total Credits (Grade E)	:	0	*based on document of academic transcript*		0
(v)	Total Credits (Grade D or D+)	:	6	*based on document of academic transcript*		6
(w)	GPA ((t)/(s))	:	2.64	*critical*		2.638 *critical*
(x)	Percentage of Grade E ((u)/(s))	:	0	*non-critical*		0 *non-critical*
(y)	Percentage of Grade D+, D ((v)/(s))	:	5.7%	*non-critical*		5.71% *non-critical*
(z)	Critical status based on (w), (x) and (y)	:	*non-critical*			*non-critical*
	DECISION MAKING					
(aa)	Decision Alternatives based on (r)	:	*Allow tuition waivers* *Allow Extension Payment Due* *Drop Out* *Not Eligible to attempt mid-term exam* *Not Eligible to graduate*			*Allow tuition waivers* *Allow Extension Payment Due* *Drop Out* *Not Eligible to attempt mid-term exam* *Not Eligible to graduate*
(ab)	Decision Alternatives based on (z)	:	*Grant Scholarship* *No Penalty*			*Grant Scholarship* *No Penalty*
(ac)	**Completion Time**	:	**6-10 minutes**			**15-20 seconds**

Fig. 10 – Performance Comparison of Old System vs Proposed System

5. Conclusion

Prototype of decision support system that was designed and developed, through this study. The proposed prototype has been able to support the calculation of the total amount of debts and the duration of arrears of each student as well as distinguish the critical level of each student in terms of tuition fees problem or academic performance, ranging from very critical with red colour code, yellow for critical, and green for non-critical condition. According to the director, the existing decision making process usually took 6-10 minutes to collect the required information before making an analysis and determining the final decision. However, after using the proposed prototype of DSS, the required information has been collected in the system so that the decision making process can be performed quicker up to 20 seconds to get the final decision, because decision alternatives have been provided in the system display. Moreover, it increases the flexibility to obtain required data compared to the existing system which is still collected manually as well as most of the calculations which play an important role as key parameters to make final decisions. Therefore, the accuracy of calculation could be improved through the support from the system.

One of the shortcomings of this study is that only view data can be accessed to develop the prototype. In addition, the approval from the director of the institution is required to implement the prototype into a real DSS application. Furthermore, if there are any additional parameters that need to be considered in the decision making process toward students' tuition fee problem, the decision table needs to be updated, and therefore the existing information system as well as the DSS application should get regular maintenance. Since the only user of the DSS system in this study is the director of the institution, thus we can only conduct an interview to see the response toward the proposed system. In the future the prototype of the proposed system needs to be implemented with complete and up-to-date data and the acceptance of decision makers toward the system should be further analyzed.

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Disclaimer

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