Proceedings of the 1st Faculty of Industrial Technology International Congress
International Conference
Bandung, Indonesia, October 9-11, 2017
ISBN 978-602-53531-8-5

Decision Support System for Bank Credit Application using Simple Additive Weighting Method

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Abstract

Decision Support System (DSS), in general, is a system that helps the decision-making process. In most applications, DSS is used to help managers in making business decisions, to improve data processing, to speed up business process, and to improve the quality and the service of banking credit approval. This paper discusses the process of building a DSS for banking credit approval using Simple Additive Weighting (SAW). SAW, which is one of the Multi-Attribute Decision Making methods, is a multicriteria decision-making technique which emphasizes the relative importance of the corresponding criterion to generate debtor's eligibility ranks to be used as the bases for banking credit grants. This study was conducted at Bank Perkreditan Rakyat Syariah (BPRS) Al-Salaam in Bandung.

Keywords: Decision Support System, Simple Additive Weighting, multicriteria decision-making, banking credit grant, eligibility rank.

1. Introduction

Banking institutions offer many monetary services; credit is one of those services. Credit is a monetary equivalent of a money or bill, subject to an agreement or an interbank borrowing and lending agreement with another party requiring the borrowing party to repay its debt after a certain period of time and with a predetermined interest amount. For the convenience of credit activities between the bank and the customer, the bank needs to assess and determine the prospective customer before coming to the decision to grant or decline credit request, this is due to the high risk of bad credits. A customer, in simpler words, should meet the criteria required by the bank before credit is granted. This situation requires banks to be able to take careful decisions in a short time considering the increasingly competitive banking business environment.

BPR Syariah (Sharia Rural Bank) is one type of banking institutions that concentrates its business in giving credits in accordance with Islamic Sharia Law. However, despite their specialization on giving banking credits, most BPR Syariahs have not utilized DSS for credit approvals. Usually approvals were made manually.

Decision Support System (DSS) is part of computer-based information systems including knowledge-based systems or knowledge management used to support decision making within an organization or company. It can also be considered as a computer system that processes data into information to take decisions from a semi-structured problem that is specific.

The problem formulation in this research is how to apply Simple Additive Weighting (SAW) method in Decision Support System in determining the rank and eligibility of prospective customers who apply for credit. The scope of this research is the criteria and the weight of criteria used by the bank. The expected results obtain from this calculation is feasibility rate of each debtor or credit applicant. The granted applicants are the ones who have the highest scores resulting from SAW calculations through a web-based application that was built as a part of this research.

The aim of this research is to build a Decision Support System application for ranking credit applicants using Simple Additive Weighting (SAW) method, while the expected outcome is an application that is capable of making quality decision in determining applicants to be granted bank credit.

2. Methodology

2.1. Decision Support System

A Decision Support System (DSS) is a computer-based information system that supports business or organizational decision-making activities. DSS helps people make decisions about problems that may be rapidly changing and not easily specified in advance. A DSS can be either fully computerized, human-powered or a combination of both. The support given by DSS can be separated into three distinct, interrelated categories: Personal Support, Group Support, and Organizational Support (Turban et. al., 2008).

The framework of Decision Support System consists of four phases:

- **Intelligence Phase**
  This first phase of the framework deals with the searching for conditions that call for decision.
- **Design Phase**
  This phase is the second step, which mostly the phase of developing and analyzing possible alternative actions of solution.
- **Choice Phase**
  In this third step, the commonly taken action is to select a course of action among those alternatives resulted in from the Design Phase.
- **Implementation Phase**
  And the final phase is to adopt the selected course of action in decision situation.

The utilization scheme of DSS in credit application process to be developed within BPR Syariah Al-Salaam Bandung's business process context can be seen as follow.

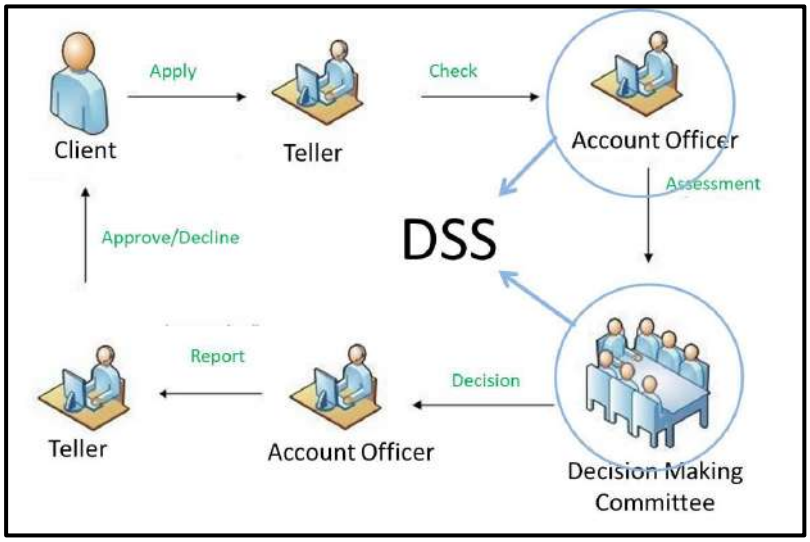

Fig. 1: DSS utilization scheme in BPR Syariah Al-Salaam's business process

2.2. Simple Additive Weighting (SAW) Method

Simple Additive Weighting Method (SAW), which is also known as weighted linear combination or scoring method, is the most popular and commonly used method of Multi Criteria Decision Making (MCDM) methods for evaluating a number of alternatives in terms of a number of decision criteria. The method is based on the weighted average. The advantage of this method is that it is a proportional linear transformation of the raw data.

The logic of the Simple Additive Weighting is to obtain a weighted sum of performance ratings of each alternative over all attributes (Roberson and Perry, 2007). The procedure is as follows:

1) Construct the criteria matrix.
2) Construct the normalized criteria matrix.
3) Weigh the normalized criteria matrix.
4) Rank the alternatives
5) Select the best alternative.

Normalization is an imperative step in Simple Additive Weighting method. There are two scenarios when normalizing criteria matrix.

The first scenario is the criteria of benefit. These criteria mean the higher numbers resulting from the normalization, the more desirable. The calculation for criteria of benefit is using the following equation.

$$r_{ij} = \frac{d_{ij}}{d_{ij}^{max}} \quad (1)$$

The second scenario is the criteria of cost. These criteria mean exactly the opposite of the criteria of benefit, i.e. the lower numbers resulting from the normalization, the more desirable. And, the normalization for criteria of cost is using equation as follows.

$$r_{ij} = \frac{d_{ij}^{min}}{d_{ij}} \quad (2)$$

where

r_{ij} : Normalized performance score

d_{ij} : Attibute score of each criterion

Max d_{ij} : Maximum score of each criterion

Min d_{ij} : Minimum score of each criterion

3. SAW Decision Making Simulation: BPR Syariah Case Study

Eligibility rank for credit approval in BPR Syariah in this phase of the process was then simulated using Simple Additive Weighting. This simulation used actual customers' data and information, and implemented the SAW procedure as discussed in the previous section.

3.1. Step 1: Construct the criteria matrix

In this phase, each criterion and its weight were determined. The criteria and their weight shown in the table below were pre-determined by BPR Syariah using its standard calculation.

Table 1: Pre-determined Criteria Matrix of BPR Syariah

C(i)	Criteria	Weight
C1	Occupation	**20%**
C2	Earnings	**25%**
C3	Collateral Value	**25%**
C4	Dependents	**10%**
C5	Home Ownership Status	**20%**

Next, a score matrix for each criterion was developed. The matrix is as seen below.

Table 2: Score Matrix guidance for each criterion

C(i)	Criteria	Score			
		1	2	3	4
C1	Occupation	Farmer/ Breeder	Private Sector Worker	Entrepreneur	State Owned Sector (BUMN) Worker
C2	Earnings	< 1,5 Million	1,5 to 3 Million	3 to 5 Million	> 5 Million
C3	Collateral Value	125 - 150 % from loan	151 - 175 % from loan	176 - 200 % from loan	> 200 % from loan
C4	Dependents	≥10	7 - 9	4 - 6	≤ 3
C5	Home Ownership Status	Rented	Mortgage	Family owned	Own house

Below is the simulation of criteria profiling using actual BPR Syariah clients' data and information.
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Table 3: Criteria simulation using actual data samples

Alternatives (Client)		Criteria				
		Occupation	Earnings	Collateral Value	Dependents	Home Ownership Status
1	Ade Rohaya	State Worker	3 Million	180%	4	Own House
2	Devi Mulyani	Private Sector Worker	1,5 Million	125%	2	Rented
3	Dhamar Gunawan	State Worker	4 Million	175%	5	Mortgage

The next step was weighting the data from the table above using the score matrix. The result is as seen below.

Table 4: Score Matrix simulation result

Alternatives	Criteria				
	C1	C2	C3	C4	C5
A1	4	3	3	3	4
A2	2	1	1	4	1
A3	4	3	2	3	2

3.2. Step 2: Construct the normalized criteria matrix

The result from weighting each criterion in Table 4 above was then normalized using Criteria of Benefit equation. All criteria after conversion to the score matrix are benefit attributes. The Criteria of Benefit selection was due to higher scores as preference. For example, the maximum value for C1 is 4, r11 = 4/4, r21 = 2/4, and r31 = 4/4. And the result is as seen bellow.

Table 5: Normalized Criteria Matrix scores

Alternatives	Criteria				
	C1	C2	C3	C4	C5
A1	1	1	1	0.75	1
A2	0.5	0.33	0.33	1	0.25
A3	1	1	0.67	0.75	0.5

3.3. Step 3: Weigh the normalized criteria matrix

The normalized criteria matrix was then weighted using a equation as follows.

$$v_{ij} = W_{ij} * r_{ij}, \sum_{i=1}^{n} W_i = 1 \quad (3)$$

where

V_i : The score of alternatives

W_{ij} : Weigh

R_{ij} : Normalized matrix

The weighted results are as seen below.

A1= (0.2*1) + (0.25*1) + (0.25*1) + (0.1*0.75) + (0.2*1) = 0.98
A2= (0.2*0.5) + (0.25*0.33) + (0.25*0.33) + (0.1*1) + (0.2*0.25) = 0.42
A3= (0.2*1) + (0.25*1) + (0.25*0.67) + (0.1*0.75) + (0.2*0.5) = 0.79

3.4. Step 4: Rank the alternatives

The weighted scores as results from previous processes were then rank using the following equation.

$$S_i = \sum_{j=1}^{m} v_{ij}, i = 1,2,3,\ldots,n \quad (4)$$

where

S_i : Rank

V_{ij} : The score of each alternative

And the result is as follows.

Table 6: Credit applicants ranking simulation

Alternative	Client	Weighted Score	Rank
A1	Ade Rohaya	0.98	1
A3	Dhamar Gunawan	0.79	2
A2	Devi Mulyani	0.42	3

3.5. Step 5: Select the best alternatives

As depicted from Table 6 above, the applicant who has the highest score is Ade Rohaya. In the Criteria of Benefit, higher scores are more preferable that Ade Rohaya is ranked the highest, thus eligible to get credit approval

4. BPR Syariah's Decision Support System Design and Implementation

The projected BPR Syariah's Decision Support System was modeled using a simple use case diagram as seen below.

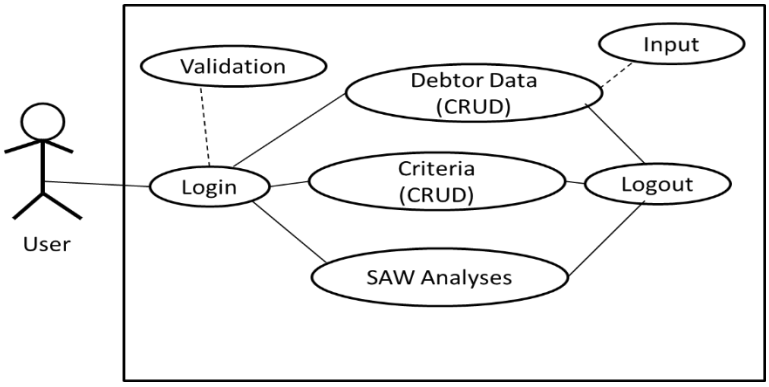

Fig. 2: BPR Syariah DSS Use Case Diagram

An implementation from the design phase was then carried out, and the most essential features from the developed DSS are as captured as follow.

Fig. 3: Login screen

Fig. 4: Home screen

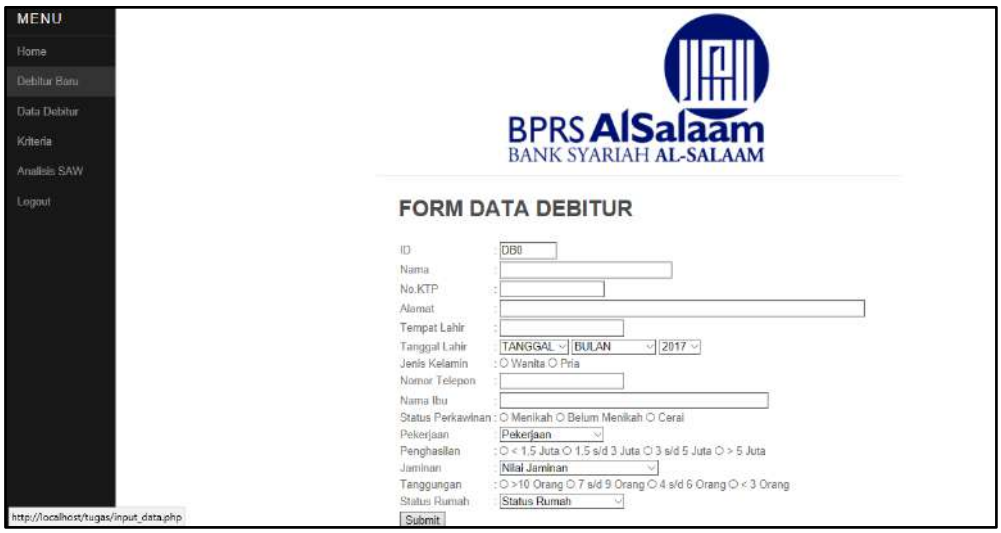

Fig. 5: Debtor application form screen

ID Debitur	C1	C2	C3	C4	C5
DB001	4	3	3	3	4
DB002	2	1	1	4	1
DB003	4	3	2	3	2

ID	Nama	C1	C2	C3	C4	C5
DB001	Ade Rohaya	1	1	1	0.75	1
DB002	Devi Mulyani	0.5	0.33	0.33	1	0.25
DB003	Dhamar Gunawan	1	1	0.67	0.75	0.5

No	ID Debitur	Nama	Nilai Preferensi
1	DB001	Ade Rohaya	0.98
2	DB002	Devi Mulyani	0.42
3	DB003	Dhamar Gunawan	0.79

Fig. 6: SAW analyses screen

5. Conclusions

Simple Additive Weighting method (SAW), one of the most popular and widely used methods of Multi Criteria Decision Making (MCDM), has been successfully applied and simulated in the process of generating credit applicants eligibility ranks. As a follow up, a Decision Support System (DSS) was then developed incorporating the simulated SAW method to improve the business process of BPR Syariah Al-Salaam Bandung in giving its services.

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