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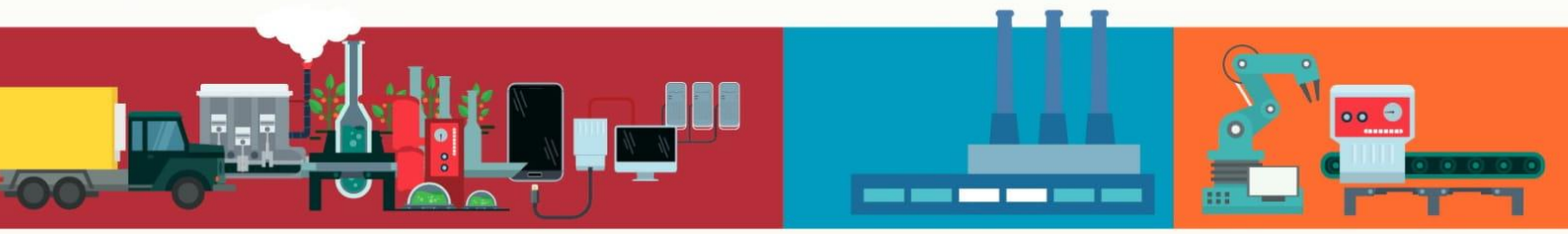

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Conference Proceedings

The 1st Faculty of Industrial Technology International Congress 2017

International Conference

Towards Reliable Renewable and Sustainable Energy Systems: Challenges and Opportunities

October 9 - 11, 2017
Faculty Building, 3rd floor
Campus of Itenas Bandung – Indonesia

Co-organized:
The ISR
Indonesian Society for Reliability
IEEE SSIT Society on Social Implications of Technology

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FACULTY OF INDUSTRIAL TECHNOLOGY INTERNATIONAL CONGRESS

(FoITIC)

PROCEEDINGS

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Conference Organizer:
Faculty of Industrial Technology, Institut Teknologi Nasional Bandung - Indonesia
Jl. PKHH. Mustapa No. 23 Bandung 40124, West Java - INDONESIA
Phone: +62-22- 7272215, Fax: +62-22 – 7202892
Email: foitic@itenas.ac.id,
Website: http://foitic.itenas.ac.id.
www.itenas.ac.id

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PREFACE
WELCOME FROM THE RECTOR
INSTITUT TEKNOLOGI NASIONAL BANDUNG

Dear speakers and participants,

Welcome to Bandung and welcome to Itenas campus!

It is great pleasure for me to welcome you in campus of Itenas Bandung at the 1st Faculty of Industrial Technology International Congress (FoITIC) 2017.

The theme for the 1st FoITIC 2017 "Toward Reliability Renewable and Sustainable Energy Systems: Challenges and Opportunities", is very relevant with the current hot issues about climate change, growing populations and limited fossil fuel resources.

We believe that scientists and researchers will hand in hand with industrial experts, to create and develop new renewable and sustainable technologies that enable human to make products and services more efficient, protect environment and keep people healthier.

I am deeply grateful appreciative to the Faculty of Industrial Technology Itenas, Indonesian Society Reliability, Institute of Electrical & Electronics Engineers Indonesia Society on Social Implication of Technology Chapter, IEEE CAS Hyderabad, delegates, organizing committee and many others who have contributed to the success of this conference.

I am confident that this event will serve to promote much valuable communication and information exchange among scientist – researcher and industrial expert.

May we have a successful, stimulating, fruitful and rewarding the conference.

Thank you.

Dr. Iman Aschuri

Rector
Institut Teknologi Nasional Bandung

PREFACE

WELCOME FROM THE DEAN OF FACULTY OF INDUSTRIAL TECHNOLOGY, INSTITUT TEKNOLOGI NASIONAL BANDUNG

Dear distinguished Guest, Ladies and Gentlemen,

Welcome to the 1st Faculty of Industrial Technology International Congress (FoITIC) 2017, which is organized by Faculty of Industrial Technology, Institut Teknologi Nasional (Itenas) Bandung, in conjunction with Indonesian Society for Reliability (ISR) and Institute of Electrical & Electronics Engineers Indonesia Society on Social Implication of Technology Chapter (IEEE Indonesia SSIT Chapter). In our Faculty, we have agreed that FoITIC event will be held every two years (biennial program).

The main theme for the 1st congress is "Towards Reliable Renewable and Sustainable Energy Systems: Challenges and Opportunities". The congress will divide into 2 (two) main programs i.e. International Conference and international workshop.

The aim of the International Conference is invites academics, researchers, engineers, government officers, company delegates and students from the field of energy and other discipline to gather, present and share the results of their research and/or work, and discuss strategies for the future utilization of renewable and sustainable energy system.

Taking this opportunity, I would like to convey my sincere thanks and appreciations to our keynote speakers and invited speakers from Szent Istvan University Hungary, IEEE Indonesia SSIT Chapter, Indonesian Society for Reliability, University Malaysia Pahang and Indonesian Wind Energy Society, workshop facilitators i.e. IEEE Circuits and Systems (IEEE CAS) Hyderabad – India) and national and international scientific committee for their support of this important event. I would also like to invite all participants in expressing our appreciation to all members of the FoITIC 2017 organizing committee for their hard work in making this conference success.

Finally, we wish you all fruitful networking during conference and workshop, and we do hope that you will reap the most benefit of it.

Do enjoy your stay in Bandung, and thank you very much!

Dr. Dani Rusirawan

Dean Faculty of Industrial Technology – Institut Teknologi Nasional Bandung
Chairman of FoITIC 2017

ACKNOWLEDGEMENT

The completion of this undertaking could not have been possible without the participation and assistance of so many people whose names may not all be enumerated. The contributions are sincerely appreciated and gratefully acknowledged. The 1st International Conference on FoITIC (Faculty of Industrial Technology Congress) Organizing Committee wishes to express its gratitude and deep appreciation to the following:

1. Dr. Imam Aschuri, Rector of Institut Teknologi Nasional Bandung;
2. All keynote and invited speakers, moderators, conference speakers, all participants and others who have in one way or another contributed for their valuable participation;
3. Institute of Electrical & Electronics Engineers Indonesia Society on Social Implication of Technology Chapter (IEEE Indonesia SSIT Chapter);
4. Institute of Electrical & Electronics Engineers Circuits and Systems (IEEE CAS), Hyderabad India;
5. Indonesian Society for Reliability (ISR);
6. Universiti Malaysia Pahang;
7. Indonesian Wind Energy Society (IWES).

KEYNOTE AND INVITED SPEAKERS INTERNATIONAL CONFERENCE

Prof. Dr. Istvan Farkas (Szent Istvan University)

Prof. Dr. Istvan Farkas is Director of Institute for Environmental Engineering System, Szent Istvan University (SZIU), Godollo – Hungary. He is also Head of Department Physics and Process Control and head of Engineering Doctoral School, at SZIU. He got Doctoral Degree from Technical University Budapest (1985). Presently, a lot of his activities devotes on International professional societies such as: International Solar Energy Societies (ISES), International Federation of Automatic Control (IFAC), European Federation of Chemical Engineering (EFChE), European Thematic Network on Education and Research in Biosystems Engineering, European Network on Photovoltaic Technologies, FAO Regional Working Group on Greenhouse Crops in the SEE Countries, Solar Energy Journal Associate Editor, Drying Technology Journal Editorial Board, etc. He was a visiting Professor in several universities: Solar Energy Applications Laboratory, Colorado University State University, Fort Collins - USA; Department of Energy, Helsinki University of Technology, Espoo - Finland; Institut for Meteorology and Physics, University of Agricultures Sciencies, Vienna - Austria; Laboratory of Bioprocess Engineering, The University of Tokyo - Japan.

Ahmad Taufik, M.Eng., Ph.D (Indonesian Society for Reliability)

Ahmad Taufik, M.Eng, Ph.D (Graduated from Georgia Institute of Technology, USA – 1996) is a lecturer and a professional trainer and consultant. He is member of American Society for Metals (ASM) and American Society for Mechanical Engineer (ASME). He performs research in fatigue and fracture mechanics of oil and gas pipeline. Dr. Ahmad Taufik highly experienced in providing industrial training and consulting work more than 20 projects related to Pipelines Failure Analysis, Risk and Reliability Assessment, Repair Design, Pipeline Corrosion Protection in Oil and Gas Industries. Dr. Ahmad Taufik has been chairman and speakers for many Oil and Gas International Conferences in Indonesia, (INDOPIPE, MAPREC), Malaysia (ASCOPE), Singapore and China (IPTEC) for the last five years. He is founder of Indonesian Society Reliability (ISR) and presently he is a chairman of the ISR. Since 2006, he was work as part time lecturer at Dept. of Mechanical Engineering, Itenas.

Prof. Dr. Soegijardjo Soegijoko (Institut Teknologi Nasional Bandung)

Soegijardjo Soegijoko (born in Yogyakarta, 1942) earned his Engineer Degree in Telecommunication Engineering from the Department of Electrical Engineering, Institut Teknologi Bandung (ITB), Indonesia, in 1964. His Doctor Degree (*Docteur Ingenieur*) was obtained from USTL (*Universite des Sciences et Techniques du Languedoc, Montpellier, France*) in 1980. Additionally, he has also completed a number of non-degree or post-doctoral programs, such as: tertiary education (UNSW, Australia, 1970), VLSI Design (Stanford University – 1986; UNSW- 1991; Tokyo Institute of Technology-1984, 1985, 1990).

Since 1966, he joined ITB as a teaching staff at the Department of Electrical Engineering, (currently School of Electrical Engineering & Informatics) ITB, and appointed as a Professor on Biomedical Engineering in 1998. During his academic services at ITB (from 1966 – 2007), he has actively involved in the developments and operations of various units, e.g.: Electronics Laboratory, Master Program on Microelectronics, Inter University Center on Microelectronics, Biomedical Engineering Program (Undergraduate, Master & Doctorate programs), and Biomedical Engineering Laboratory. Although he has been officially retired in 2007, he has appointed as an adjunct Professor at ITB for some years. At present (August 2017), he is an adjunct Professor at the Department of Electrical Engineering, Institut Teknologi Nasional (ITENAS) Bandung (Indonesia). His current research interests include: Biomedical Engineering Instrumentation, e-Health &Telemedicine Systems, and Biomedical Engineering Education.

He has published more than 100 international papers in the above-mentioned research interests. Moreover, he (and his colleagues) have also authored five different book chapter titles (on biomedical engineering, ehealth & telemedicine) published by Jimoondang (Korea, 2008), Springer (Singapore, 2014), CRC Press – Taylor Francis (2016), and Springer (2017).

Currently, he actively involves in various societies within the IEEE that include: EMBS, SSIT, CASS, Computer, and Education, as well as SIGHT (Special Interest Group on Humanitarian Activities). He is currently the IEEE Indonesia SSIT Chapter Chair, EMBS Chapter Chair and actively involves in the Indonesian eHealth & Telemedicine Society (IeHTS) as well as the Indonesian Biomedical Engineering Society (IBES).

Prof. Dr. Ir. Soegijardjo Soegijoko is a *Life Senior Member* of the IEEE, and can be reached through: soegi@ieee.org

Prof. Dr. Rizalman Mamat (Universiti Malaysia Pahang)

Prof. Dr. Rizalman Mamat presently is Dean of Faculty Mechanical Engineering, Universiti Malaysia Pahang, Malaysia. He got Doctoral degree from University of Birmingham, United Kingdom in fuel and energy. Previously, he obtained his BSc and MSc from University Teknologi Malaysia (UTM). His field research interest is Heat transfer, Combustion, Internal Combustion Engine, Alternative Energy, Computational Fluid Dynamics, Propulsion System. Prof. Dr. Rizalman Mamat was visiting Professor at Karlsruhe University of Applied Science Germany (2017), Faculty of Engineering Universitas Abulyatama Aceh, Indonesia (2017), Faculty of Engineering Universitas Gajah Putih Aceh, Indonesia (2017), Department of Mechanical Manufacture & Automation Ningxia University, Yinchuan, China (2016), Department of Mechanical Manufacture & Automation Ningxia University, Yinchuan, China (2015).

Mr. Soeripno Martosaputro (Indonesia Wind Energy Society)

Soeripno Martosaputro, graduated from Universitas Sebelas Maret (Bachelor) and University of Pancasila (MSc.). Presently, he is worked at PT UPC Renewables. Moreover, he is Chairman of Indonesia Wind Energy Society (IWES) and Chairman of Expert Board of Indonesia Wind Energy Association (IWEA). Previously he worked as a researcher at the National Institute of Aeronautics and Space (LAPAN), Aerospace Technology Center, particularly in the field of technology development and engineering of the Wind Energy Conversion Systems. He is active in the field of science and technology utilization in particular wind energy technology as speakers and resource persons in seminars nationally and internationally. He is member of the Asia Pacific Wind Energy Forum (APWEF), Indonesia National Committee World Energy Congress (KNI-WEC), Indonesia Renewable Energy Society (METI), and National Research Council (DRN). In 2012 – 2016, he was act as National Project Manager of WHYPGEN (Wind Hybrid Power Generation market initiatives Project) – UNDP Project.

LIST OF CONTENTS

Proceedings of the 1st Faculty of Industrial Technology International Congress
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Decision Support System for Bank Credit Application using Simple Additive Weighting Method

Budiraharjo[1,*], Mira Musrini[1], and Willy Edya Sukma[2]

[1] Department of informatics, Institut Teknologi Nasional (Itenas), Bandung - INDONESIA

[2] Student Department of informatics, Institut Teknologi Nasional (Itenas), Bandung - INDONESIA

[*] Corresponding author e-mail: budiraharjo@itenas.ac.id

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.

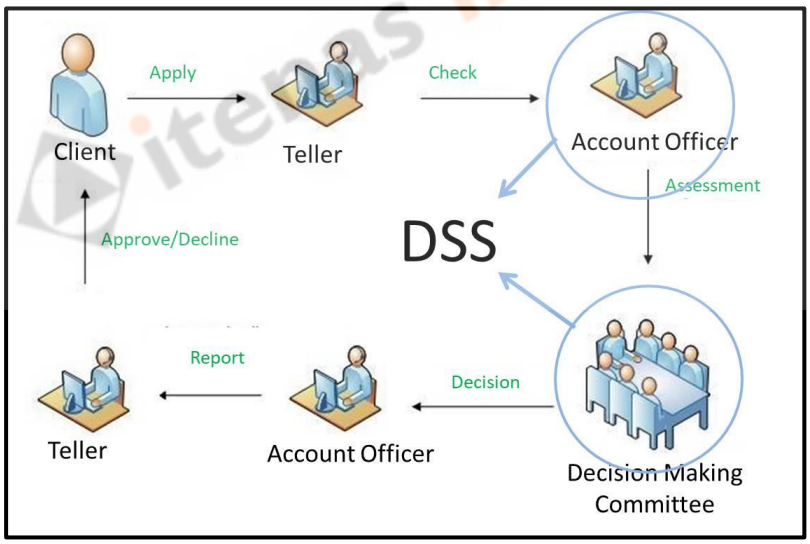

Fig. 1: DSS utilization scheme in BPR Syariah Al-Salaam's business process

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.
/

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.

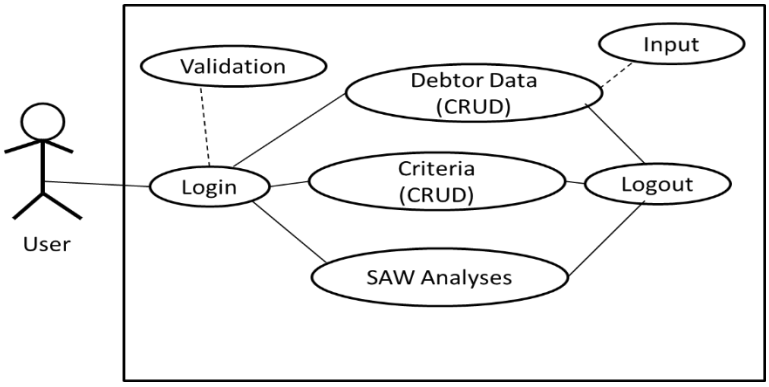

Fig. 2: BPR Syariah DSS Use Case Diagram

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

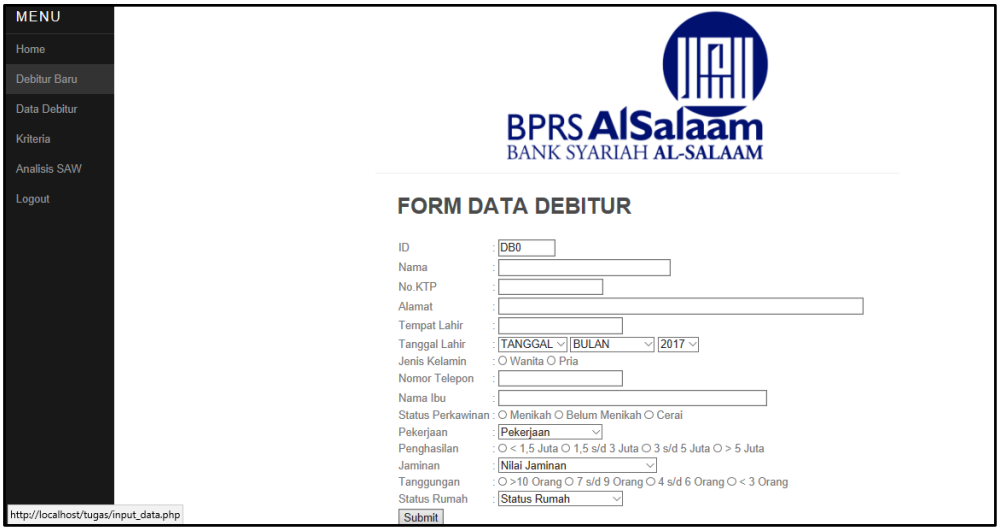

Fig. 5: Debtor application form screen

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.

6. References

Adriyendi. 2015. Multi-Attribute Decision Making Using Simple Additive Weighting and Weighted Product in Food Choice. International Journal of Information Engineering and Electronic Business, Vol. 6, pp. 8-14.

C. Ruan, and J. Yang. 2015. Hesitant Fuzzy Multi-Attribute Decision-Making Method Considering the Credibility. Journal of Computational Information Systems, Vol. 11, pp. 423-432.

Edya Sukma, Willy. 2017. Pembangunan Sistem Pendukung Keputusan Pengajuan Kredit Dengan Metode Simple Additive Weighting (SAW) (Studi Kasus : BPR Syariah). Bandung, Tugas Akhir Jurusan Teknik Informatika.

Efraim Turban; Jay E. Aronson; Ting-Peng Liang. 2008. Decision Support Systems and Intelligent Systems. New Jersey: US, Prentice Hall, Inc.

F. Burstein; C. W. Holsapple. 2008. Handbook on Decision Support Systems. Berlin: Springer Verlag.

Gachet, A. 2004. Building Model-Driven Decision Support Systems with Dicodess. Zurich, VDF.

K. S. S. Anupama, S. S. Gowri, B. P. Rao, and P. Rajesh. 2015. Application of MADM Algorithms to Network Selection. International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering, Vol. 3, Issue 6, pp. 64-67.

Kulik, C., L. Roberson and E. Perry. 2007. The Multiple-Category Problem: Category Activation and Inhibition in the Hiring Process. Acad. Manage. Rev., Vol. 32 No. 2, pp. 529-48.

L. Abdullah and C.W. R. Adawiyah. 2014. Simple Additive Weighting Methods of Multi Criteria Decision Making and Applications: A Decade Review. International Journal of Information Processing and Management, Vol. 5, No. 1, pp. 39-49.

Triantaphyllou, E. 2000. Multi-Criteria Decision Making: A Comparative Study. Dordrecht, The Netherlands: Springer.