Journal of Information System Exploration and Research

https://shmpublisher.com/index.php/joiser

p-ISSN 2964-1160 | e-ISSN 2963-6361

Decision Support System for Program Indonesia Pintar Recipients Using the Fuzzy Multi-Criteria Decision-Making Method

Abdul Hamid[1*], Muhammad Sandi Rais[2], M. Idris R[3], Salamun[4], Yonhendri[5], Ahmad Zulfan[6], Lasmi Oyong[7]

[1]*Faculty of Technical and Vocational Education, Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja Batu Pahat Johor Malaysia*

[2,3,5,6,7]*Informatics Engineering, STIKOM Muhammadiyah Batam, Indonesia*

DOI: https://doi.org/10.52465/joiser.v1i2.157

Received 07 April 2023; Accepted 26 Juny 2023; Available online 26 Juny 2023

Article Info

Keywords:
Program Indonesia Pintar (PIP);
Decision support system;
FMCDM

Abstract

Program Indonesia Pintar (PIP) is the development of Bantuan Siswa Miskin (BSM) program, which covers students from the learning stages of SD or MI, SMP or MTs, SMA or Sekolah Menengah Kejuruan (SMK), the PIP Program is a National Program that aims to eliminate barriers to poor students participating in studying by helping poor students get access to appropriate learning services, avoiding dropping out of school, attracting poor students to return to study, helping students fulfill their desires in upgrading activities. Through the Program Indonesia Pintar (PIP), school-age children from poor households or families can continue to study, do not drop out of school. No recipients are on the wrong target for assistance from the Smart Indonesia Program at SMP Negri 39 Pekanbaru City. The method used in the decision support system is Fuzzy Multi-Criteria Decision Making (FMCDM) which assesses alternative determinants so that they can be used in policy analysis in decision-making. The results of this decision support will help decide the best choice of several substitutes based on the selected criteria.

1. Introduction

Multi-Criteria Decision Making (MCDM) has been widely used in a wide range [1]. The PIP Program is a National Program that aims to remove barriers to poor students participating in studying by helping poor students get access to appropriate learning services, avoid dropping out of school, attract poor students to return to study, help students fulfill their desires in upgrading activities, supporting the program Must Practice Lower 9 Years Education (especially to the upper secondary level), and help the smooth running of the school program.

* ***Corresponding Author:***

Abdul Hamid,
Faculty of Technical and Vocational Education,
Universiti Tun Hussein Onn Malaysia,
86400 Parit Raja Batu Pahat Johor Malaysia.
Email: abdulhamid@uthm.edu.my

Through the Smart Indonesia Program (PIP), it is hoped that school-age children from poor households or families will be able to study. As with the poor scholarship assistance or Bantuan Siswa Miskin (BSM), this program is like direct support to students and not scholarships because it originates from the student's economic condition and is not sourced from results (scholarships) considering the student's condition.

In principle, a decision support system is only a support system for collecting decisions [2]. A decision support system is computer-based to support decision-based systems [3], [4], [5]. A decision support system is a computer-based information system that produces various alternative decisions to assist management in dealing with structured and unstructured problems using data and models [6], [7].

This decision-making is used in selecting groups to make rankings which will then become several criteria that need to be evaluated [8], [9], [10]. Doing calculations for qualitative to quantitative data becomes the result of calculations in decision-making [11], [12], [13]. Decision-making is essential in the ultra-modern world despite being invaded by various technological advances that are updated to help decision tools [14]. Technology alone sometimes fails to produce decisions without considering human cognitive abilities [15], [16], [17]. This decision-making method used in policy analysis uses the Fuzzy Multi-Criteria Decision Making (FMCDM) method. Decision makers express their opinions using fuzzy sets, which were first introduced by [18] FMCDM (Fuzzy Multi-Criteria Decision Making) is a decision-making method for determining the best alternative out of several alternatives based on specific criteria [19].

FMCDM is a method that can be used as a decision support tool [20], [21]. Multi-Criteria Decision Making (MCDM) refers to screening, prioritizing, ranking, or selecting alternative sets with independent, proportional, or conflicting conditional criteria.

In previous research, Fuzzy Multi-Criterisa Decision Making (FMCDM) was also used in Decision Making research on selecting prospective employees at PT. Angkasa Global Consultants determines employee acceptance based on several criteria, namely GPA, Individual Skills, Work Experience, and Age [22]. FMCDM was also used in the research to analyze the risks associated with photovoltaic power generation, the supply chain, and its impact on the social and environmental dimensions of sustainability. Through risk management based on the five dimensions of sustainable development, the researchers successfully demonstrated that photovoltaic energy has minimal adverse impacts on the social and environmental dimensions of sustainability [23]. To guide investors and policymakers, FMCDM is used to assist in selecting the most optimal prime movers for combined heat and power (CHP) system operations. The research utilized FMCDM to evaluate and prioritize prime movers based on technical, economic, environmental, and social [24]. In the research conducted [25], FMCDM is used in the analysis and evaluation of integrated energy system (IES) performance through the construction of criteria systems, modeling of criteria calculations, and the use of evaluation methods such as TODIM with the aim of providing comprehensive and measurable information support for integrated energy providers and expanding methods and applications in decision making.

2. Method

In researching to obtain optimal results, it is mandatory to follow the established principles (methods). The steps of this research are described as an activity framework. The steps of the research are presented in Figure 1.

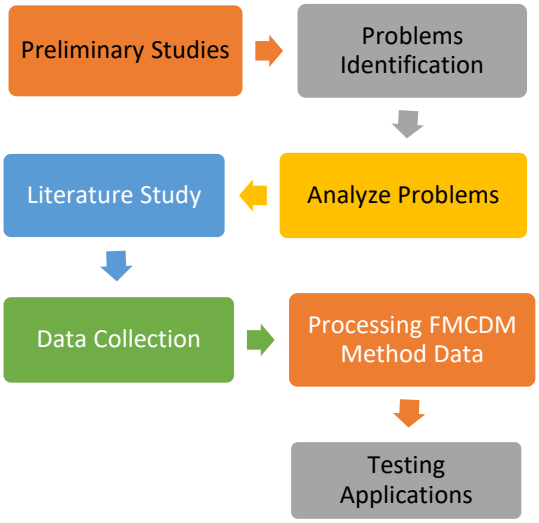

Figure 1. Research framework

Based on the activity framework in Figure 1. So, each stage can be described as follows:

3.1. Preliminary Studies

In this step, monitoring the problems to be monitored are attempted to examine and process data and examine the current cases more deeply. This step is an early stage to conclude the problem: (a) What is the Fuzzy Multi-Criteria Decision Procedure for Providing Solutions for the recipients of the Smart Indonesia Program? (b) How to Implement the Fuzzy Multi-Criteria Decision-Making Procedure for Decision Support Systems for recipients of the Smart Indonesia Program?

3.2. Problems Identification

In this step, the problems that will be the research subject are formulated. The formulation of the problem was tried to determine what problems existed in the research subjects and the boundaries of the cases to be studied.

3.3. Problems Identification

Analyzing problems is meant to be able to master the problems that have been defined within the scope or boundaries. By analyzing the problems that are determined, the problems can be adequately understood. The problems that arise are how the Fuzzy Multi-Criteria Decision-Making Method provides solutions for the Smart Indonesia Program recipients based on the criteria. How to apply the Fuzzy Multi Criteria Decision Making Method for a Decision Support System for recipients of Program Indonesia Pintar.

3.4. Literature Review

Theories related to Decision Support Systems (DSS), Fuzzy Multi Criteria Decision Making (FMCDM), and Website Platform applications are studied through literature studies.

3.5. Data Collection

In collecting information and data, it is tried to identify the system under study at this step. Information will be received from the information and data collected to support research. The author used the method for data collection in various ways: (a) Carrying out direct observations at the research site, namely at SMP Negeri 39 Pekanbaru. Observations in this way identify existing cases. (b) Interviews were attempted to obtain the necessary data or information by conducting direct question and answer methods at directives or related sections at SMP Negeri 39 Pekanbaru. (c) In this method, data is combined by reading journals related to using the Fuzzy Multi-Criteria Decision Making method for

collecting these decisions to facilitate and generate references in the determination method for recipients of the Smart Indonesia Program at SMP Negeri 39 Pekanbaru.

3.6. Processing FMCDM Method Data

This step intends to process data using the Fuzzy Multi-Criteria Decision Making (FMCDM) method. This step intends to divide the priority of decision replacement based on accumulated results and select the decision replacement with the highest priority as the optimal replacement.

3.7. Testing Applications

Testing was attempted to equalize the results obtained in the system application step. Do the results receive match those of the trial being attempted.

The practical steps consist of several methods, including: (a) Ascertaining the requirements part of the benchmark options is the rating of the needs of each benchmark and the suitability rating of the replacement to the decision benchmark, can be seen example in Table 1, and Table 2. (b) Verify replacement parts conformity to criteria. (c) Verify the share of the needs of each substitute to the criteria. (d) Aggregating the weights of the criteria as well as the suitability of each replacement by the criteria. From that using the mean operator, Fi is formulated in equation (1). (e) Selecting the highest priority decision substitute as the optimal alternative.

Table 1. Rating of the needs of each criterion

Criteria	C1.	C2.	C3.	C4.
Requirement Rating				

Table 2. Alternative similarity rating on criteria

	Similarity Rating			
Alternative	C1.	C2.	C3.	C4.
A1				
A2				
A3				
A4				
A5				

$$F=\left(\frac{1}{k}\right)\left[(S_{t1}\otimes W_1)\otimes(S_{t2}\otimes W_2)\otimes\wedge\otimes(S_{tk}\otimes W_k)\right] \quad (1)$$

3. Results and Discussion

3.1. System Description

This section also presents the results of the research obtained from questionnaire data that was tested on the direction of SMP Negeri 39 Pekanbaru and sourced from the technical instructions for Program Indonesia Pintar (PIP) which is used as a benchmark guide for acceptors of the Smart Indonesia Program, otherwise the alternative is students of Program Indonesia Pintar. VII and VIII at SMP 39 Pekanbaru. The data that has been obtained is all the wisdom of the leadership of SMP Negeri 39 Pekanbaru and is processed and continued using the Fuzzy Multi Criteria Decision Making (FMCDM) method where the application used in system testing is a Website Platform Application.

3.1.1. Fuzzy Multi Criteria Decision Making (FMCDM) Concept

Fuzzy Multi Criteria Decision Making (FMCDM) is a procedure for collecting decisions to decide the best choice from several substitutes based on the selected criteria. Benchmarks are generally in the form of measurements, norms or standards used in decision making. On the other hand, the MCDM method, especially the AHP and ANP techniques, has been criticized by several researchers for

improving these two techniques, including Asadabadi et al [26], the quality of the requirements for each benchmark and the suitability rating of the replacement for the decision benchmark, the result will be the best choice. The choices in selecting beneficiaries of Program Indonesia Pintar can be seen in Table 3.

Table 3. Alternative Information

Alternative	Information
A_1	Muhammad Arif Putra
A_2	Sari Wulan
A_3	Hoiriah
A_4	Wandra Gustri Leo
A_5	Novita Desisari Marbun

The alternatives used in determining the beneficiaries of Program Indonesia Pintar are students of SMP Negeri 39 Pekanbaru. On the other hand, the criteria used in determining the recipients of the Smart Indonesia Program were sourced from data and interviews from SMP Negeri 39 Pekanbaru and sourced from Program Indonesia Pintar (PIP) technical guidelines as shown in table 4.

Table 3. Criteria Information

Criteria	Information
$C_{1.}$	Recipients of BSM 2014
$C_{2.}$	KPS/KKS holders
$C_{3.}$	Participants of PKH
$C_{4.}$	Orphaned
$C_{5.}$	Disaster Impact
$C_{6.}$	Once drop-out
$C_{7.}$	Poor Family
$C_{8.}$	Special
$C_{9.}$	Field Group

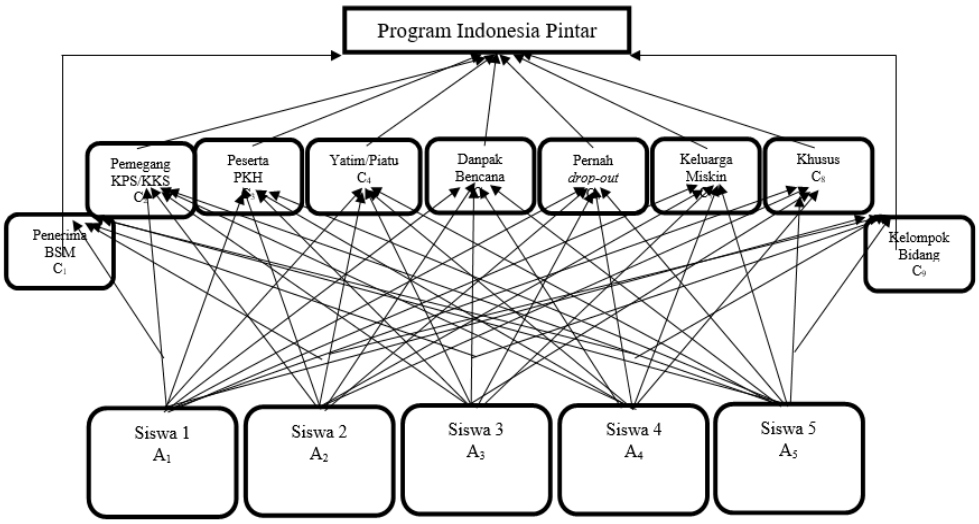

Figure 1. Hierarchical structure of the problem

Figure 1 explains that recipients of Program Indonesia Pintar must meet the criteria. Several alternatives will be compared with predetermined criteria values. These criteria are 2021 BSM Beneficiaries (C1), KPS/KKS Holders (C2), PKH Participants (C3), Orphans/Orphans (C4), Disaster Respondents (C5), Ever dropped-out (C6), Poor Families (C7), Special (C8), Field Group (C9).

In order to determine the importance of each substitution to the criterion, the fuzzy number skill function used is the triangular fuzzy value function, whose member function has been displayed on equation (2) as membership function.

$$\mu(x) = \begin{cases} \dfrac{(x-a)}{(b-a)}; a \le x \le b \\ \dfrac{(x-c)}{(b-c)}; b \le x \le c \\ 0; \ldots \ge b \ldots or \ldots x \ge c \end{cases} \quad (2)$$

Figure 2 shows a diagram for membership weights (T) of critical importance (W) using triangular fuzzy sets.

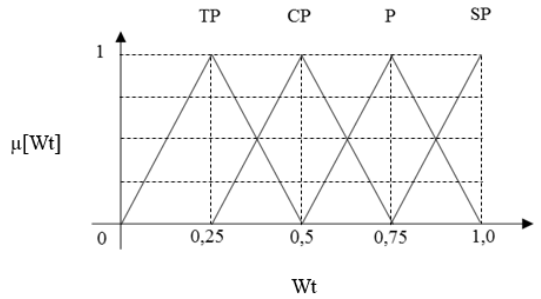

Figure 2. Members to the weight of interest against each criterion with the set of triangular fuzzy numbers

Information,
TP = Tidak Penting (Not Important)
CP = Cukup Penting (Fairly Important)
P = Penting (Important)
SP = Sangat Penting (Very Important)

The linguistic variables that represent the weight of the need for each criterion are: T (Importance) W= TP, CP, P, SP with TP= Not Important, CP= Fairly Important, P= Important, SP= Very Important, each of which explained with the results of triangular fuzzy numbers as follows: TP = {0, 0.25, 0.5}; CP = {0.25, 0.5, 0.75}; P = {0.5, 0.75, 1}; SP = { 0.75, 1, 1 }.

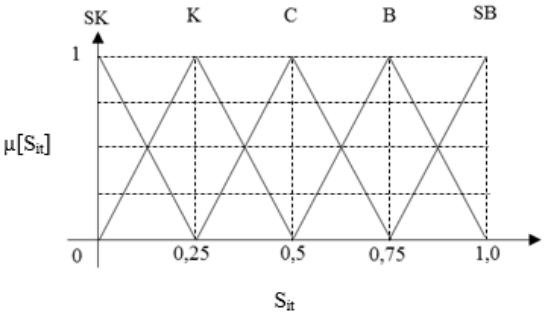

Figure 3. Use members on the weight of suitability of each alternative on each decision criteria of the set of triangular fuzzy numbers

Information,
SK = Sangat Kurang (Very Less)
K = Kurang (Less)
C = Cukup (Fairly)
B = Baik (Good)
SB = Sangat Baik (Very Good)

Figure 3 shows the results of the suitability of the alternatives with the principle of conformity, namely: T (Suitability) S = SK, K, C, B, SB, with SK = Very Less, K = Less, C = Fairly, B = Good, and SB = Very Good, each of which is explained in the triangular fuzzy number value applies as follows: SK = {0, 0, 0.25}; K = {0, 0.25, 0.5}; C = {0.25, 0.5, 0.75}; B = {0.5, 0.75, 1}; SB = {0.75, 1, 1}.

Table 4. Importance rating for each criterion

Criteria	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9
Rating	SP	SP	P	SP	P	SP	P	P	TP

Explanation of Table 4 for beneficiaries of Program Indonesia Pintar are BSM 2021 Beneficiaries (C1), KPS or KKS Holders (C2), PKH Participants (C3), Orphans/Orphans (C4), Disaster Respondents (C5), Have dropped out (C6). Poor Families (C7). Special (C8), and Field Group (C9). For the importance rating for each criterion, there are three criteria, namely C1, C2, C4, and C6 which have a very important importance rating (SP), C3, C5, C7 and C8 which have an important importance rating (P), and C9 which has an importance rating. Not Important (TP). Next, the conformity rating for each alternative for each criterion can be seen in Table 5.

Table 5. Conformity rating of each alternative on each criterion

Alternative	Conformity Rating								
	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9
A_1	SB	SB	B	B	B	B	SB	SB	SK
A_2	B	SB	B	B	B	B	B	SB	SK
A_3	SB	SB	B	SB	B	B	B	B	SK
A_4	B	SB	B	B	B	B	SB	B	SK
A_5	B	B	SB	B	B	B	SB	SB	SK

By substituting triangular fuzzy numbers for each linguistic variable into matches (3), (4) and (5) the fuzzy suitability numbers are obtained in the chart, can be shown in Table 6.

Table 6. Rating of importance and rating on suitability of each criterion for alternative A_1

Criteria	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9
Interest	SP	SP	P	SP	P	SP	P	P	TP
Compatibility	SB	SB	B	B	B	B	SB	SB	SK

Information for alternative A1 (Muhammad Arif Putra), and for the criteria, namely 2021 BSM Recipients (C1), KPS/KKS Holders (C2), PKH Participants (C3), Orphans/Orphans (C4), Disaster Danpak (C5), Ever dropped -out (C6), Poor Families (C7), Special (C8), Field Group. The importance rating is Very Important (SP), P (Important), and Not Important (TP). Conformity Rating SB (Very Good), B (Good), and Very Poor (SK). In order to find the suitability index value for each of the other options Y1, Q1, and Z1, for each rating the numbers are obtained from the suitability SB (Very Good), B (Good), and Very Poor (SK). To find the suitability index value for each alternative Y1, Q1, and Z1, for each rating the value is taken from the fuzzy triangle.

Y_1=1/9*((SP*SB)+(SP*SB)+(P*B)+(SP*B)+(P*B)+(SP*B)+(P*SB)+(P*SB)+(TP*SK))
=1/9*((0.75*0.75)+(0.75*0.75)+(0.5*0.5)+(0.75*0.25)+(0.5*0.25)+(0.25*0.5)+(0.5*0.75)+(0.5*0.75)+(0*0)) = **0.347222222**

Q_1=1/9*((SP*SB)+(SP*SB)+(P*B)+(SP*B)+(P*B)+(SP*B)+(P*SB)+(P*SB)+(TP*SK))
=1/9*((1*1)+(1*1)+(0.75*0.75)+(1*0.75)+(0.75*0.75)+(1*0.75)+(0.75*1)+(0.75*0.75)+(0.25*0)) = **0.659722222**

Z_1=1/9*((SP*SB)+(SP*SB)+(P*B)+(SP*B)+(P*B)+(SP*B)+(P*SB)+(P*SB) +(TP*SK))
=1/9*((1*1)+(1*1)+(1*1)+(1*1)+(1*1)+(1*1)+(1*1)+(1*1)+(0.5*0.25))
= **0.902777778**

In alternative A_1 to find the suitability index for each alternative Y_1, Q_1, and Z_1 obtained from Table 5. The suitability rating of each alternative against each criterion, and obtained for each alternative is Table 6. The need rating and suitability rating of each benchmark for Alternative A_1 . From the results of the calculation above, it appears that the substitute for A_1 (Muhammad Arif Putra) has a fuzzy match index: 0. 347222222; 0. 659722222; 0. 902777778.

Table 7. Rating of importance and rating on suitability of each criterion for alternative A_2

Criteria	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9
Interest	SP	SP	P	SP	P	SP	P	P	TP
Compatibility	SB	SB	B	B	B	B	SB	SB	SK

Table 7 for alternative A2 (Wulan Sari), and for the criteria, namely 2021 BSM Recipients (C1), KPS/KKS Holders (C2), PKH Participants (C3), Orphans/Orphans (C4), Disaster Danpak (C5), Ever drop-out (C6), Poor Family (C7), Special (C8), Field Group. The importance rating is Very Important (SP), P (Important), and Not Important (TP). Conformity Rating SB (Very Good), B (Good), and Very Less (SK). To find the suitability index value for each alternative Y1, Q1, and Z1, for each rating the value is obtained from the triangular fuzzy.

Alternative A_2

Y_1=1/9*((SP*B)+(SP*SB)+(P*B)+(SP*B)+(P*B)+(SP*B)+(P*B)+(P*SB)+(TP*SK)) =
1/9*((0.75*0.5)+(0.75*0.75)+(0.5*0.5)+(0.75*0.5)+(0.5*0.5)+(0.75*0.5)+(0.5*0.5)+(0.5*0.75)+(0*0)) =
0.3125

Q_1=1/9*((SP*B)+(SP*SB)+(P*B)+(SP*B)+(P*B)+(SP*B)+(P*B)+(P*SB)+(TP*SK)) =
1/9*((1*0.75)+(1*1)+(0.75*0.75)+(1*0.75)+(0.75*0.75)+(1*0.75)+(0.75*0.75)+(0.75*1)+(0.25*0)) =
0.631944444

Z_1=1/9*((SP*B)+(SP*SB)+(P*B)+(SP*B)+(P*B)+(SP*B)+(P*B)+(P*SB)+(TP*SK)) =
1/9*((1*1)+(1*1)+(1*1)+(1*1)+(1*1)+(1*1)+(1*1)+(1*1)+(0.5*0.25))= **0.902777778**

In substitution A_2 to find the suitability index for each alternative Y1, Q1, and Z1 is obtained from Table 5. The suitability rating of each alternative against each benchmark, and obtained for each alternative in chart Table 7. The importance rating and the suitability rating of each criterion for the alternative A_2. From the calculation results above, it can be seen that alternative A_2 (Wulan Extract) has a fuzzy match index: 0.3125; 0. 631944444; 0. 902777778.

Table 8. Rating of importance and rating on suitability of each criterion for alternative A_3

Criteria	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9
Interest	SP	SP	P	SP	P	SP	P	P	TP
Compatibility	SB	SB	B	B	B	B	SB	SB	SK

Explanation of Table 8 for alternative A_3 (Hoiriah), and for criteria namely BSM 2021 Recipients (C1), KPS/KKS Holders (C2), PKH Participants (C3), Orphans/Orphans (C4), Disaster Danpak (C5), Ever dropped -out (C6), Poor Families (C7), Special (C8), Field Group. The importance rating is Very Important (SP), P (Important), and Not Important (TP). Conformity Rating SB (Very Good), B (Good), and Very Less (SK). In order to find the suitability index value for each alternative Y1, Q1, and Z1, for each rating the value is obtained from the fuzzy triangle.

Alternative A_3

Y_1=1/9*((SP*SB)+(SP*SB)+(P*B)+(SP*SB)+(P*B)+(SP*B)+(P*B)+(P*B)+(TP*SK))=
1/9*((0.75*0.75)+(0.75*0.75)+(0.5*0.5)+(0.75*0.75)+(0.5*0.5)+(0.75*0.5)+(0.5*0.5)+(0.5*0.5)+(0*0))
= 0.340277778

Q_1=1/9*((SP*SB)+(SP*SB)+(P*B)+(SP*SB)+(P*B)+(SP*B)+(P*B)+(P*B)+(TP*SK))=
1/9*((1*1)+(1*1)+(0.75*0.75)+(1*1)+(0.75*0.7)+(1*0.75)+(0.75*0.75)+(0.75*0.75)+(0.25*0))
= **0.666666667**

Z_1=1/9*((SP*SB)+(SP*SB)+(P*B)+(SP*SB)+(P*B)+(SP*B)+(P*B)+(P*B)+(TP*SK))=
1/9*((1*1)+(1*1)+(1*1)+(1*1)+(1*1)+(1*1)+(1*1)+(1*1)+(0.5*0.25)) = **0.902777778**

In alternative A3 to find the suitability index for each alternative Y1, Q1, and Z1 obtained from Table 5. The suitability rating for each alternative for each criterion, as well as for each alternative, is shown in Table 8. The importance rating and suitability rating for each benchmark for Alternative A3. From the calculation results above, it appears that alternative A3 (Hoiriah) has a fuzzy match index: 0. 340277778; 0. 666666667; 0. 902777778.

Table 9. Rating of importance and rating on suitability of each criterion for alternative A_4

Criteria	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9
Interest	SP	SP	P	SP	P	SP	P	P	TP
Compatibility	SB	SB	B	B	B	B	SB	SB	SK

Explanation of Table 9 for alternative A4 (Wandra Gustri Leo), and for the criteria, namely 2021 BSM Recipients (C1), KPS/KKS Holders (C2), PKH Participants (C3), Orphans/Orphans (C4), Disaster Danpak (C5), Have dropped out (C6), Poor Family (C7), Special (C8), Field Group. The importance rating is Very Important (SP), P (Important), and Not Important (TP). Conformity Rating SB (Very Good), B (Good) and Very Poor (SK). In order to find the suitability index value for each alternative Y1, Q1, and Z1, for each rating the value is obtained from the fuzzy triangle.

Alternative A_4

Y_1=1/9*((SP*B)+(SP*B)+(P*SB)+(SP*B)+(P*B)+(SP*B)+(P*SB)+(P*B)+(TP*SK))=
1/9*((0.75*0.5)+(0.75*0.5)+(0.5*0.75)+(0.75*0.5)+(0.5*0.5)+(0.75*0.5)+(0.5*0.75)+(0.5*0.5)+(0*0)) = **0.305555556**

Q_1=1/9*((SP*B)+(SP*B)+(P*SB)+(SP*B)+(P*B)+(SP*B)+(P*SB)+(P*B)+(TP*SK))=
1/9*((1*0.75)+(1*0.75)+(0.5*1)+(1*0.75)+(0.75*0.75)+(1*0.75)+(0.75*1)+(0.75*0.75)+(0.25*0)) = **0.597222222**

Z_1=1/9*((SP*B)+(SP*B)+(P*SB)+(SP*B)+(P*B)+(SP*B)+(P*SB)+(P*B)+(TP*SK))=
1/9*((1*1)+(1*1)+(1*1)+(1*1)+(1*1)+(1*1)+(1*1)+(1*1)+(0.5*0.25)) = **0.902777778**

In alternative A4 to find the suitability index for each alternative Y1, Q1, and Z1 obtained from Table 5. The suitability rating of each alternative against each criterion, and obtained for each alternative in Table 9. The importance rating and the suitability rating of each benchmark for the alternative A4. From the calculation results above, it appears that alternative A4 (Wandra Gusri Leo) has a fuzzy match index: 0. 305555556; 0. 597222222; 0. 902777778.

Table 10. Rating of importance and rating on suitability of each criterion for alternative A_5

Kriteria	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9
Interest	SP	SP	P	SP	P	SP	P	P	TP
Compatibility	SB	SB	B	B	B	B	SB	SB	SK

Explanation of Table 10 on alternative A5 (Novita Desisari Marbun), and on the criteria, namely 2021 BSM Recipients (C1), KPS/KKS Holders (C2), PKH Participants (C3), Orphans/Orphans (C4), Disaster Danpak (C5), Have dropped out (C6), Poor Family (C7), Special (C8), Field Group. The importance rating is Very Important (SP), P (Important), and Not Important (TP). Conformity Rating SB (Very Good), B (Good), and Very Poor (SK). In order to find the suitability index value for each alternative Y1, Q1, and Z1, for each rating the value is obtained from the fuzzy triangle

Alternative A_5

Y_1=1/9*((SP*B)+(SP*B)+(P*SB)+(SP*B)+(P*B)+(SP*B)+(P*SB)+(P*SB)+(TP*SK))=
1/9*((0.75*0.5)+(0.75*0.5)+(0.5*0.75)+(0.75*0.5)+(0.5*0.5)+(0.75*0.5)+(0.5*0.75)+(0.5*0.75)+(0*0)) = **0.319444444**

Q_1=1/9*((SP*B)+(SP*B)+(P*SB)+(SP*B)+(P*B)+(SP*B)+(P*SB)+(P*SB)+(TP*SK))=
1/9*((1*0.75)+(1*0.75)+(0.75*1)+(1*0.75)+(0.75*0.75)+(1*0.75)+(0.75*1)+(0.75*1)+(0.25*0)) = **0.645833333**

Z_1=1/9*((SP*B)+(SP*B)+(P*SB)+(SP*B)+(P*B)+(SP*B)+(P*SB+(P*SB)+(TP*SK))=
1/9*((1*1)+(1*1)+(1*1)+(1*1)+(1*1)+(1*1)+(1*1)+(1*1)+(0.5*0.25))= **0.90277777**

In alternative A_5 to find the suitability index for each alternative Y1, Q1, and Z1 obtained from Table 5. The suitability rating of each alternative against each criterion, and obtained for each alternative in Table 10. The importance rating and the suitability rating of each benchmark for the alternative A5. From the calculation results above, it appears that alternative A5 (Novita Desisari Marbun) has a fuzzy match index: 0. 319444444; 0. 645833333; 0. 902777778.

Table 11. Compatibility index on each alternative

Alternative	Compatibility Rate									Index Compatibility Fuzzy		
	C1	C2	C3	C4	C5	C6	C7	C8	C8	*Y1*	*Q1*	*Z1*
A1	SB	SB	B	B	B	B	SB	SB	SK	0.347222222	0.659722222	0.902777778
A2	B	SB	B	B	B	B	B	SB	SK	0.3125	0.631944444	0.902777778
A3	SB	SB	B	SB	B	B	B	B	SK	0.340277778	0.666666667	0.902777778
A4	B	B	SB	B	B	B	SB	B	SK	0.305555556	0.597222222	0.902777778
A5	B	B	SB	B	B	B	SB	SB	SK	0.319444444	0.645833333	0.902777778

By circulating the fuzzy suitability index in table 3.10 and by quoting the optimistic part (α) = 0 (Not Optimistic), (α) = 0.5 and (α) = 1 (Very Optimistic), so that an integral value for each replacement. Calculations for value (α) = 0 are obtained from table 5. 0 with agreement (7).

$I\frac{0}{1}$ = ($\frac{1}{2}$)*((0)*(0.819444)+(0.590278)+(1-0)*(0.2847222)) = **0.503472222**
$I\frac{0}{1}$ = ($\frac{1}{2}$)*((0)*(0.819444)+(0.569444)+(1-0)*(0.25)) = **0.472222222**
$I\frac{0}{1}$ = ($\frac{1}{2}$)*((0)*(0.875)+(0.618056)+(1-0)*(0.3055556)) = **0.503472222**
$I\frac{0}{1}$ = ($\frac{1}{2}$)*((0)*(0.819444)+(0.576389)+(1-0)*(0.2708333)) = **0.451388889**
$I\frac{0}{1}$ = ($\frac{1}{2}$)*((0)*(0.847222)+(0.590278)+(1-0)*(0.2638889)) = **0.482638889**
Perhitungan untuk nilai (α) = 0.5
$I\frac{0}{1}$ = ($\frac{1}{2}$)*((0.5)*(0.819444)+(0.590278)+(1-0.5)*(0.2847222)) = **0.642361111**
$I\frac{0}{1}$ = ($\frac{1}{2}$)*((0.5)*(0.819444)+(0.569444)+(1-0.5)*(0.25))= **0.619791667**
$I\frac{0}{1}$ = ($\frac{1}{2}$)*((0.5)*(0.875)+(0.618056)+(1-0.5)*(0.3055556))= **0.644097222**
$I\frac{0}{1}$ = ($\frac{1}{2}$)*((0.5)*(0.819444)+(0.576389)+(1-0.5)*(0.2708333)) = **0.600694444**
$I\frac{0}{1}$ = ($\frac{1}{2}$)*((0.5)*(0.847222)+(0.590278)+(1-0.5)*(0.2638889)) = **0.628472222**
Perhitungan untuk nilai (α) = 1
$I\frac{0}{1}$ = ($\frac{1}{2}$)*((1)*(0.819444)+(0.590278)+(1-1)*(0.2847222)) = **0.78125**
$I\frac{0}{1}$ = ($\frac{1}{2}$)*((1)*(0.819444)+(0.569444)+(1-1)*(0.25)) = **0.767361111**
$I\frac{0}{1}$ = ($\frac{1}{2}$)*((1)*(0.875)+(0.618056)+(1-1)*(0.3055556))= **0.784722222**
$I\frac{0}{1}$ = ($\frac{1}{2}$)*((1)*(0.819444)+(0.576389)+(1-1)*(0.2708333)) = **0.75**
$I\frac{0}{1}$ = ($\frac{1}{2}$)*((1)* ((1)*(0.847222)+(0.590278)+(1-1)*(0.2638889)) = **0.774305556**

Table 12. The integral total value of each alternative

Alternative	Integral Total Value			Total	Alternative
	α = 0	α = 0.5	α = 1		
A1	0.503472222	0.642361111	0.78125	1.927083333	Muhammad Arif Putra
A2	0.472222222	0.619791667	0.767361111	1.859375	Wulan Sari
A3	0.503472222	0.644097222	0.784722222	1.932291667	Hoiriah
A4	0.451388889	0.600694444	0.75	1.802083333	Wandra Gustri Leo
A5	0.482638889	0.628472222	0.774305556	1.885416667	Novita Desisari Marbun

In Table 12 it can be seen that A_3 has the highest number of overall integrals. From the calculation of the overall value ranking of all the alternatives available, it appears that alternative A_3 (Hoiriah) has the highest score, as a result it can be concluded that this alternative is the best alternative.

4. Conclusion

Based on the analysis, planning and application of the fuzzy multiple criteria system decision-making for advice on determining beneficiaries of Program Indonesia Pintar, several conclusions can be formulated, among others, (1) The advantage of the support system for determining the acceptor determination of the Smart Indonesia Program using a fuzzy multiple criteria decision making procedure is that it can support the user in proposing students who are categorized as students who have the right to accept the support of the Smart Indonesia Program from some of the alternative options available even though the substitutes are have indeterminate data; (2) The results of using the fuzzy multiple criteria decision making method from 5 students obtained the final result with the highest score of 1.932291667, namely Hoiriah deserves to be recommended to receive the Smart Indonesia Program, the variables used in the F-MCDM system can be tried to add, it does not rule out the possibility of using increase the specific variable in order to make recommendations for students who have the right to receive a more specific Smart Indonesia Program.

References

[1] S. French, "Reflections on 50 Years of MCDM: Issues and Future Research Needs," *EURO J. Decis. Process.*, vol. 11, no. November 2022, p. 100030, 2023, doi: 10.1016/j.ejdp.2023.100030.

[2] H. J. Pasman, W. J. Rogers, and S. W. Behie, "Selecting a method/tool for risk-based decision making in complex situations," *J. Loss Prev. Process Ind.*, vol. 74, no. March 2021, p. 104669, 2022, doi: 10.1016/j.jlp.2021.104669.

[3] G. H. de Paula Vidal, R. G. G. Caiado, L. F. Scavarda, P. Ivson, and J. A. Garza-Reyes, "Decision support framework for inventory management combining fuzzy multicriteria methods, genetic algorithm, and artificial neural network," *Comput. Ind. Eng.*, vol. 174, no. October, 2022, doi: 10.1016/j.cie.2022.108777.

[4] R. G. G. Caiado, L. F. Scavarda, L. O. Gavião, P. Ivson, D. L. de M. Nascimento, and J. A. Garza-Reyes, "A fuzzy rule-based industry 4.0 maturity model for operations and supply chain management," *Int. J. Prod. Econ.*, vol. 231, no. July 2020, 2021, doi: 10.1016/j.ijpe.2020.107883.

[5] P. Pampouktsi *et al.*, "Techniques of Applied Machine Learning Being Utilized for the Purpose of Selecting and Placing Human Resources within the Public Sector," *J. Inf. Syst. Explor. Res.*, vol. 1, no. 1, pp. 1–16, 2022, doi: 10.52465/joiser.v1i1.91.

[6] Y. Yun, D. Ma, and M. Yang, "Human–computer interaction-based Decision Support System with Applications in Data Mining," *Futur. Gener. Comput. Syst.*, vol. 114, pp. 285–289, 2021, doi: 10.1016/j.future.2020.07.048.

[7] Y. Zhang, H. Huang, L. X. Yang, Y. Xiang, and M. Li, "Serious challenges and potential solutions for the industrial internet of things with edge intelligence," *IEEE Netw.*, vol. 33, no. 5, pp. 41–45, 2019, doi: 10.1109/MNET.001.1800478.

[8] P. Riliandini, E. N. Dianti, S. R. Hidayah, D. Ananda, and A. Pertiwi, "Improved logistics service quality for goods quality delivery services of companies using analytical hierarchy process," *J. Soft Comput. Explor.*, vol. 2, no. 1, 2021, doi: 10.52465/joscex.v2i1.21.

[9] S. Zakeri, P. Chatterjee, N. Cheikhrouhou, and D. Konstantas, "Ranking based on optimal points and win-loss-draw multi-criteria decision-making with application to supplier evaluation problem," *Expert Syst. Appl.*, vol. 191, no. November 2020, p. 116258, 2022, doi: 10.1016/j.eswa.2021.116258.

[10] J. M. Sánchez-Lozano, A. Moya, and J. M. Rodríguez-Mozos, "A fuzzy Multi-Criteria Decision Making approach for Exo-Planetary Habitability," *Astron. Comput.*, vol. 36, p. 100471, 2021, doi: 10.1016/j.ascom.2021.100471.

[11] J. C. Pena, G. Nápoles, and Y. Salgueiro, "Normalization method for quantitative and qualitative attributes in multiple attribute decision-making problems," *Expert Syst. Appl.*, vol. 198, no. November 2021, 2022, doi: 10.1016/j.eswa.2022.116821.

[12] A. Mohamed, F. Business, A. Alden, A. Mohamed, S. Al Mohamed, and M. Zino, "Application of fuzzy multicriteria decision - making model in selecting pandemic hospital site," *Futur. Bus. J.*,

2023, doi: 10.1186/s43093-023-00185-5.
[13] F. Sitorus, J. J. Cilliers, and P. R. Brito-Parada, “Multi-criteria decision making for the choice problem in mining and mineral processing: Applications and trends,” *Expert Syst. Appl.*, vol. 121, pp. 393–417, 2019, doi: 10.1016/j.eswa.2018.12.001.
[14] R. Michaela Denise Gonzales and C. A. Hargreaves, “How can we use artificial intelligence for stock recommendation and risk management? A proposed decision support system,” *Int. J. Inf. Manag. Data Insights*, vol. 2, no. 2, p. 100130, 2022, doi: 10.1016/j.jjimei.2022.100130.
[15] C. Kern, F. Gerdon, R. L. Bach, F. Keusch, and F. Kreuter, “Humans versus machines: Who is perceived to decide fairer? Experimental evidence on attitudes toward automated decision-making,” *Patterns*, vol. 3, no. 10, p. 100591, 2022, doi: 10.1016/j.patter.2022.100591.
[16] G. Nápoles, I. Grau, L. Concepción, L. Koutsoviti Koumeri, and J. P. Papa, “Modeling implicit bias with fuzzy cognitive maps,” *Neurocomputing*, vol. 481, pp. 33–45, 2022, doi: 10.1016/j.neucom.2022.01.070.
[17] N. Mehrabi, F. Morstatter, N. Saxena, K. Lerman, and A. Galstyan, “A Survey on Bias and Fairness in Machine Learning,” *ACM Comput. Surv.*, vol. 54, no. 6, 2021, doi: 10.1145/3457607.
[18] C. W. Liu and S. C. Kang, “A video-enabled dynamic site planner,” *Comput. Civ. Build. Eng. - Proc. 2014 Int. Conf. Comput. Civ. Build. Eng.*, vol. 353, pp. 1562–1569, 2014, doi: 10.1061/9780784413616.194.
[19] P. Zhang, Z. Zhang, D. Gong, and X. Cui, “A novel normal wiggly hesitant fuzzy multi-criteria group decision making method and its application to electric vehicle charging station location,” *Expert Syst. Appl.*, vol. 223, no. October 2022, p. 119876, 2023, doi: 10.1016/j.eswa.2023.119876.
[20] M. Abdel-Basset, A. Gamal, and S. S. Teleb, “Intelligent fuzzy decision-making system of afforestation in new cities: A case study of the New Administrative Capital, Egypt,” *Intell. Syst. with Appl.*, vol. 14, 2022, doi: 10.1016/j.iswa.2022.200085.
[21] İ. Kaya, M. Çolak, and F. Terzi, “A comprehensive review of fuzzy multi criteria decision making methodologies for energy policy making,” *Energy Strateg. Rev.*, vol. 24, no. May 2017, pp. 207–228, 2019, doi: 10.1016/j.esr.2019.03.003.
[22] M. A. Wardana, “Implementasi Metode Fuzzy Multi Attribute Decision Making Pada Sistem Seleksi Penerimaan Calon Karyawan Baru Pt . Angkasa Global,” vol. 2, pp. 67–73, 2019.
[23] S. Shojaeimehr and D. Rahmani, “Risk management of photovoltaic power plants using a novel fuzzy multi-criteria decision-making method based on prospect theory: A sustainable development approach,” *Energy Convers. Manag. X*, vol. 16, no. July, p. 100293, 2022, doi: 10.1016/j.ecmx.2022.100293.
[24] M. A. Alao, O. M. Popoola, and T. R. Ayodele, “Sustainable prime movers selection for biogas-based combined heat and power for a community microgrid: A hybrid fuzzy multi criteria decision-making approach with consolidated ranking strategies,” *Energy Convers. Manag. X*, vol. 16, no. July, p. 100281, 2022, doi: 10.1016/j.ecmx.2022.100281.
[25] J. Zhou, Y. Wu, C. Wu, Z. Deng, C. Xu, and Y. Hu, “A hybrid fuzzy multi-criteria decision-making approach for performance analysis and evaluation of park-level integrated energy system,” *Energy Convers. Manag.*, vol. 201, no. September, p. 112134, 2019, doi: 10.1016/j.enconman.2019.112134.
[26] M. R. Asadabadi, E. Chang, and M. Saberi, “Are MCDM methods useful? A critical review of Analytic Hierarchy Process (AHP) and Analytic Network Process (ANP),” *Cogent Eng.*, vol. 6, no. 1, 2019, doi: 10.1080/23311916.2019.1623153.