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Rank Computation Model for Distribution Product in Fuzzy Multiple Attribute Decision Making

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Abstract

Ranking of an activity is very important to support work effectiveness. Previous works, ranking for distribution product is used by manual process or averaging value. Problem in this research, the research should be found the effective way to rank the distribution product. This research proposes assist the ranking with a computational model based on Fuzzy Multiple Decision Making (FMADM). Getting an effective ranking, a variable in FMADM computing is required. Variables is used in this research such as number of households, number of small-scale enterprises run by households, gross domestic regional income, and economic growth rate of a region. Research completion is assisted by using self-built research methods. Research method consists of determining value of origin, determining degree of membership, determining weight of each variable, calculation of relation matrix, calculation of the preference value in each village for ranking value, and last is sorting. Operationalized FMADM is gain a result with three priorities district. Priority number one is all of district that have a rank or Vij (alternative rank) higher than 0.4. It means only 7% or 5 villages with the highest rank. Priority number second s all of district that have rank between V_{ij}=0.26 and V_{ij}=0.4. It means only 62% or 44 villages. Priority number three is district that have a rank lower than V_{ij}=0.26, and only 31% or 22 villages. Impact in use of FMADM, calculated in rank, is the process runs effective and dynamic with changing of weighted. User can arrange of weighted as needed.

Keywords*: rank, computation model, distribution product, fuzzy*

1. Introduction

Ranking is an aspect that is often used to determine the priority of an activity. Ranking in the priority setting or sequence of an activity, can be influenced by several things. For an example, ranking for students, who actually get scholarship [1], is studied by utilizing variables such as salary, value, family number, and distance [1].

Another activity is ranking of assist organizations/institutions such as priority in product assistance in terms of distribution. Ranking of product distribution activities is necessary, especially in assistant provided by the organization/institution. Distribution of product assistance from organizations/institutions is often misplaced. For example, the distribution of products, often people who need them, they have not received the assistance. It situation can be inaccurately targeted in distribution of products and often loss of control.

Ranking in a variety of purposes often becomes an obstacle, due to the cognitive limitations of decision making. Use of ranking variables often based on the aspects of the value of values alone. This evidence will result in inequality of various decision-makers. For example, distribution of products from an organization/institution, use of a receiving variable is measured only by the willingness or unwillingness of the recipient. This case will highlight the recipient aspect of only one variable answer is acceptance (accepted/rejected). Difficulties and limitations of human cognitive aspects are often based on ease in an answer only. Moreover, customer aspect should be targeted to a certain number, sometime, it often negates other aspects. Some problems that have completed work by Fuzzy MADM Model are also used to solve the ranking problem in terms of hybrid network [2]. At [3], Fuzzy MADM is used to assess an institution's management portfolio. Fuzzy MADM is completed the ranking for Web services with QoS-based

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(Quality of Service) [4]. Various problem solving can be solved with Fuzzy MADM computing [5-11].

Based on previous description, in this research is directed to a problem formulation, how to make an information about rank or priority of beneficiaries of an organization/institution by utilizing Fuzzy computational model based on Multiple Attribute Decision Making (MADM). Purpose of this study is to provide information, a support for decision makers, and that cognitive aspects of human beings can be assisted with computational modeling. This research also needs boundaries. Boundaries will restrict the research and expected results do not deviate from the desired goal. Boundaries of the problem from this study are related to data and computational models. Data have used from result of questionnaire of 71 villages with 44961 more households in certain districts in a region. These data are associated with variables such as the number of households, small and medium enterprises in each household, GRDP (gross regional domestic income) and LPE (economic growth rate) of a particular region. While for research computation model is using Simple Additive Weighting (SAW).

Fuzzy MADM is a fuzzy technique used to solve the selection problem of a limited number of alternatives [3]. This model is widely used to solve the problems like science management, economics, psychometrics, marketing research, applied statistics, decision theory [3]. Some fuzzy techniques have been used MADM model. This model is applied in Simple Additive Weighting Method (SAW), Weighted Product (WP), ELECTRE, and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), and Analytic Hierarchy Process (AHP) [3, 6, 8, 10].

2. Methodology

2.1. Definitions

Rank is an important sequence of events that have been processed. The sequence can be based on the variable of an event [1]. At [3], ranking is a priority assessment on an institution/profit organization for an investment. Meanwhile, computational model is a model created with the help of computer system by using a certain algorithm to complete the calculation process. Understanding computation is often used to solve problems that require a computer to see the process, time, and results of a model [1]. Another definition about distribution, distribution means the process that shows the distribution of goods from producers to consumers. Distribution is an economic activity that bridges production and consumption activities [9]. To accomplish this research, we have used several steps such as determine Fuzzy value (include in Fuzzy MADM), Inference the fuzzy value, defuzzification. At below, we explain every step in the research.

2.2. Fuzzy MADM (Multiple Attribute Decision Making)

Fuzzy MADM is used in various fields as described above [1, 3], [5-8], [10-15]. At [1] Fuzzy MADM model is used to determine the order of scholarship recipients in junior high school. At [7], the Fuzzy MADM model is used to rank a department at a university. The fuzzy model to be used is the model of [1] and [4]. Fuzzy MADM itself requires a criterion and an alternative choice of the issues studied. The algorithms written by [1], [4] can be seen at Table 1. Variables C is defined as criteria that are involved such as households, UM, PDRB, and LPE. Another variable is A. It means alternative choose from district which has selected. Variable R means normalization matrix that structured from two indices. Row defines as alternative, and column defines as criteria.

Table 1. Algorithm for Fuzzy MADM Process [2, 4, 6, 9, 12]

Algorithm FuzzyMADM (set of criteria (Ci), set of alternative (Ai))

a) Set Of Criteria (C_1,C_2,C_3,…,C_i), where i<=n {n=the number of criteria}

b) Set of Alternative (A_1,A_2,A_3,…,Aj), wherer j<=m { m=number of alternative}

c) Input (W), where W ∈ {w1,w2,w3,…,wk} and k=n, {k=series of weighting based on Ci,n=k }

d) // Making Normalization Matrix R (relation) from Criteria (Ci) and Alternative (Aj)

For i=1 to n

For j=1 to m

$$r_{ij} = \begin{cases} \dfrac{x_{ij}}{\underset{i}{Max} x_{ij}} & \text{iff j is beneficiary attributes} \quad (1) \\ \dfrac{\underset{i}{Min} x_{ij}}{x_{ij}} & \text{iff j is cost} \quad (2) \end{cases}$$

e) // Making preference from matrix R and W, using formula

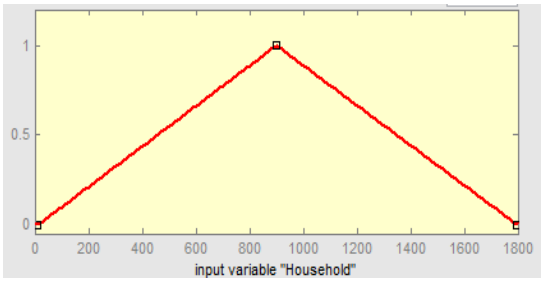
$$V_j = \sum_{j=1}^{N} W_J R_{IJ} \quad (3)$$

where Ri,j=matrix relations, and Vj=number of preference alternative

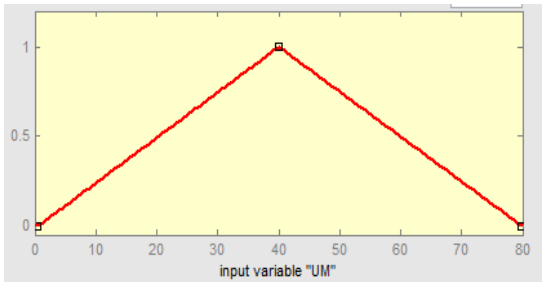
f) Return Vj, {number of preference alternative}

2.3. Membership Function

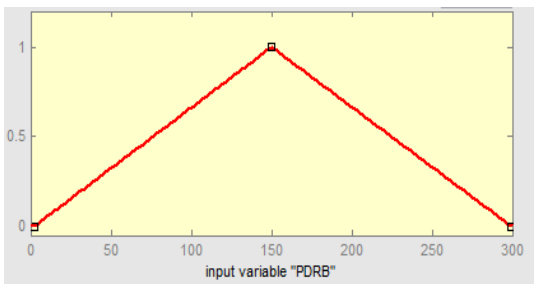
At the research [2], [10] that to facilitate the operationalization of Fuzzy variables, is used graph conversion to transform crisp value into Fuzzy value. At Figure 1, the graph function is applied to calculate the degree of membership of each criterion variable [11]. In the graph, we are determined the boundary value that arrange from each variables. Example, in the variable Households, we arranged the value between 0 and 1800. The zero value, it means that is no activity in the households. The 1800 value, it means that is amount of households activities. We have arranged the formula as can be seen in (4), (5), (6), and (7).



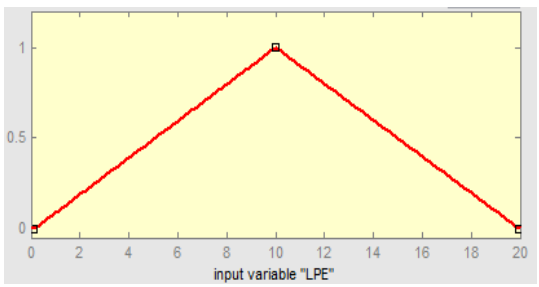
(a)



(b)



(c)



(d)

Figure 1. Memberships diagram (a) graphic “Household-HH” ,(b) graphic “UM”, (c) Graphic “GDRP”, (d) graphic “LPE” [13-15]

The value of degree of membership is obtained by converting the crisp value into fuzzy value. The formula used is as follows [14-15]:

$$\mu_{(x)} = 0, \text{iff } x \leq \text{lowerbound OR } x \geq \text{upperbound} \quad (4)$$

$$\mu_{(x)} = 1, \text{iff } \left(\frac{\text{Lowerbound+Upperbound}}{2}\right) = \text{mid} \quad (5)$$

$$\mu_{(x)} = \frac{(x-\text{lowerbound})}{\text{Mid}-\text{lowerbound}}, \text{iff } 0 < x < mid \quad (6)$$

$$\mu_{(x)} = \frac{(\text{upperbound}-x)}{\text{upperbound}-\text{mid}}, \text{iff mid } < x < upperbound \quad (7)$$

In previous works [1, 4, 7], that to determine FMADM, is required variables to be operationalized. As stated in the background, that the variables for determining rating, is number of households, GRDP, and LPE. FMADM is possible for the variables with the weights in the numeric value. In order to accomplish the research, it should be determined about direction and purpose. It is necessary that the research model should be described. We have depicted the research model to illustrate the flow of the research. At Figure 2, the block process can divide into three blocks such as Input Block, FMADM Block Process, and Output Block. Block number one, Input block is used for inputting the crisp value that will be entered. Block number two, FMADM Block Process is important block, because at this block, we will convert the crisp value into Fuzzy value. We have chosen rectangle graph to convert crisp value. Block number three, Output block is used to present the result after the FMADM process. As a result, we have proposed the rank of distribution in area manner.

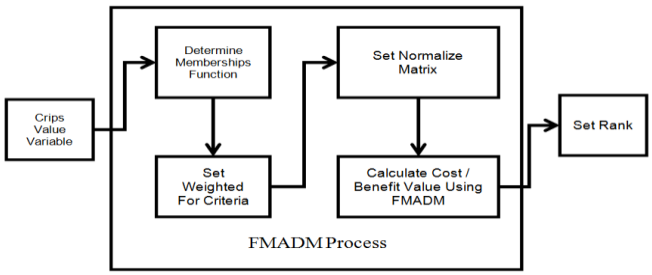


Figure 2. Research model, adopted from [1], [7]

At Figure 2, it is illustrating the flow of the research model. There are three parts in this model contain of Crips Value Variable as Input Block, FMADM Process as Fuzzy MADM Block, and Rank Set as Output Block. In FMADM Process is divided into four parts such as Determine Memberships Function, Set Weighted for criteria, Set Normalize Matrix, Calculate Cost/Benefit Value Using FMADM (create preferences).

3. Analysis

3.1. Crisp Value Variable

In the research that has been done, the data used is from the survey results directly in the field. The data collected contains the number of households, gross regional domestic income, economic growth rate, and home-based business units. At Table 2, it can be seen examples of data that have been taken.

Table 2. Example Data, Retrieved from Survey

No	District	Household (HH)	Micro Business (UM)	Gross Domestic Brute (GDRB)	Growth Rate (LPE)
1	Sebele	348	7	Rp59,501,539	Rp3,986,603
2	Lubuk Puding	905	4	Rp154,738,199	Rp10,367,459
3	Tanjung Batu Kecil	435	2	Rp74,376,924	Rp4,983,254
4	Semembang	355	45	Rp60,698,409	Rp4,066,793
5	Tanjung Kilang	451	5	Rp77,112,627	Rp5,166,546
6	Telaga Tujuh	501	21	Rp85,661,699	Rp5,739,334
7	Lubuk Semut	703	1	Rp120,199,949	Rp8,053,397
8	Parit	356	8	Rp60,869,391	Rp4,078,249
9	Selat Mendaun	270	8	Rp46,164,987	Rp3,093,054
10	Sungai Lakam Barat	1590	41	Rp271,860,482	Rp18,214,652

In this study, proposing fuzzy variables are Number of Households, Micro Enterprises, Gross Domestic Income, and Economic Growth Rate. Fuzzy FMADM requires of alternative variables and criteria variables. Research determines alternative variables such as name of the village in one of the sub-districts, while for the criteria variable are Household Number (HH), Micro Business (UM), Gross Domestic Product (GDRP), Economic growth rate (LPE) [1-7].

3.2. Determine Memberships Functions

Based on the proposed model of research at Figure 1, next step is determining degree of membership of each criterion. Graphic model that used to convert Fuzzy values is triangular graph at Figure 1. Using triangular graph is simplification process in determining conversion result for discrete or continuous values. Calculation is using formulation of Equations (4), (5), (6), (7). Result at Table 3, is gained by Fuzzy values for data at Table 2.

Table 3. Result from Membership Functions

Label Alternative	District	HH (C1)	UM (C2)	GDRP (C3)	LPE (C3)
V1	Sebele	0.39	0.18	0.40	0.40
V2	Lubuk Puding	0.99	0.10	0.97	0.96
V3	Tanjung Batu Kecil	0.48	0.05	0.50	0.50
V4	Semembang	0.39	0.88	0.40	0.41
V5	Tanjung Kilang	0.50	0.13	0.51	0.52
V6	Telaga Tujuh	0.56	0.53	0.57	0.57
V7	Lubuk Semut	0.78	0.03	0.80	0.81
V8	Parit	0.40	0.20	0.41	0.41
V9	Selat Mendaun	0.30	0.20	0.31	0.31
V10	Sungai Lakam Barat	0.23	0.98	0.19	0.18

3.3. Set Weighted For Criteria

Based on result, determination of level important on criteria is assign a weighted of criteria. Weighted criteria that have given to the variable is created by symbol like C1=HH, C2=UM, C3=GDRP, and C4=LPE. At below, Fuzzy MADM is determined by weighted that have arranged.

$$W = \{C1; C2; C3; C4\} = \{0{,}2; 0{,}15; 0{,}45; 0{,}20\} \quad (8)$$

3.4. Set Normalized Matrix (Relation Matrix - R)

The value that has been obtained in the membership, then processed to get the matrix normalization. An example of a normalized matrix calculation can use formulas (1) and (2) on the FMADM algorithm. The formula can be seen in (8), (9), (10), and (11). While table 3 there is an example of the result of normalization of fuzzy value.

$$R_{11} = \frac{0.39}{Max(0.39;0.99;0.48;0.39;0.50;0.56;0.78;0.40;0.30;0.23)} = 0.39 \quad (9)$$

$$R_{12} = \frac{Min(0.18;0.10;0.05;0.88;0.13;0.53;0.03;0.20;0.20;0.98)}{0.18} = 0.14 \quad (10)$$

$$R_{13} = \frac{Min(0.40;0.97;0.50;0.40;0.51;0.57;0.80;0.41;0.31;0.19)}{0.40} = 0.47 \quad (11)$$

$$R_{14} = \frac{Min(0.40;0.96;0.50;0.41;0.52;0.57;0.81;0.41;0.31;0.18)}{0.40} = 0.45 \quad (12)$$

3.5. Calculate Cost/Benefit Value Using FMADM (Create preference)

The next step of the FMADM calculation is to determine the preference by using formula (3). In this study, the alternative is the name of the existing village. The result of preferences calculations can be seen at Table 5.

$$V_1 = \sum_{J=1}^{4} W_J R_{1J} = (W_1 R_{11}) + (W_2 R_{12}) + (W_3 R_{13}) + (W_4 R_{14}) \quad (13)$$

Table 4. An Example Normalized Matrix Relations between Alternative and Criteria

			1	2	3	4
		1	0.39	0.14	0.47	0.45
		2	1.00	0.25	0.19	0.19
		3	0.49	0.50	0.38	0.36
R_{ij}	=	4	0.40	0.03	0.46	0.44
		5	0.50	0.20	0.36	0.35
		6	0.56	0.05	0.33	0.31
		7	0.79	1.00	0.23	0.22
		8	0.40	0.13	0.46	0.44
		9	0.30	0.13	0.61	0.58
		10	0.23	0.03	1.00	1.00

Table 5. Preferences Calculations

Preferences Calculations
$V_1 = (0.2 * 0.39) + (0.15 * 0.14) + (0.45 * 0.47) + (0.2 * 0.45) = 0.402$
$V_2 = (0.2 * 1.00) + (0.15 * 0.25) + (0.45 * 0.19) + (0.2 * 0.19) = 0.362$
$V_3 = (0.2 * 0.49) + (0.15 * 0.50) + (0.45 * 0.38) + (0.2 * 0.36) = 0.414$
$V_4 = (0.2 * 0.40) + (0.15 * 0.03) + (0.45 * 0.46) + (0.2 * 0.44) = 0.380$
$V_5 = (0.2 * 0.50) + (0.15 * 0.20) + (0.45 * 0.36) + (0.2 * 0.35) = 0.364$
$V_6 = (0.2 * 0.56) + (0.15 * 0.05) + (0.45 * 0.33) + (0.2 * 0.31) = 0.329$
$V_7 = (0.2 * 0.79) + (0.15 * 1.00) + (0.45 * 0.23) + (0.2 * 0.22) = 0.457$
$V_8 = (0.2 * 0.40) + (0.15 * 0.13) + (0.45 * 0.46) + (0.2 * 0.44) = 0.394$
$V_9 = (0.2 * 0.30) + (0.15 * 0.13) + (0.45 * 0.61) + (0.2 * 0.58) = 0.469$
$V_{10} = (0.2 * 0.23) + (0.15 * 0.03) + (0.45 * 1.00) + (0.2 * 1.00) = 0.700$

3.6. Set Rank

Looking at the hands-on run, from example 10 data, it can be sorted from highest to lowest priority. The ranking results obtained that V_{10} (Sungai Lakam Barat Village) has the highest priority in terms of receiving product or service assistance. At Table 5, an example of priority results from preference calculations.

Table 6. An Example Priority from Preferences Calculation

Priority	Village	Vij
1	Sungai Lakam Barat	0.701
2	Selat Mendaun	0.469
3	Lubuk Semut	0.457
4	Tanjung Batu Kecil	0.414
5	Sebele	0.402
6	Parit	0.394
7	Semembang	0.380
8	Tanjung Kilang	0.364
9	Lubuk Puding	0.362
10	Telaga Tujuh	0.329

4. Result

There are 71 villages with 44961 households that calculated by FMADM. Result is divided into three priorities. Priority number one is district which has low domestic income. At Table 1, the number priority start from one until five is first priority in distribution and grouped into high priority with V_{ij} >=0.4. The number priority 6 until 49 is second priority in distribution and grouped into Vij moderate priority is between V_{ij}=0.26 and V_{ij}=0.4. Last, number priority 50 until 71 is third priority and grouped into low priority V_{ij} <0.26. Operationalization Fuzzy variables have an impact in distribution priority. There are 5 villages or 7% having high priority, 62% or 44 villages with medium priority, and 31% or 22 villages with low priority.

Priority	District	Vi	Priority	District	Vi	Priority	District	Vi	Priority	District	Vi
1	SUNGAI PASIR	0.685	21	SAWANG	0.282	41	DARUSALAM	0.263	61	LUBUK	0.255
2	TANJUNG PELANDUK	0.500	22	SEBELE	0.281	42	BATU LIMAU	0.263	62	SUNGAI SEBESI	0.255
3	SUNGAI LAKAM BARAT	0.484	23	SEMEMBANG	0.279	43	BARAN TIMUR	0.263	63	PONGKAR	0.254
4	BULUH PATAH	0.463	24	PAUH	0.279	44	SUNGAI RAYA	0.262	64	TELAGA TUJUH	0.253
5	DEGONG	0.403	25	PARIT	0.278	45	PASIR PANJANG	0.262	65	JANG	0.253
6	TEBIAS	0.376	26	TELUK AIR	0.274	46	SUNGAI LAKAM TIMUR	0.262	66	SUNGAI UNGAR UTARA	0.252
7	RAWA JAYA	0.355	27	SUNGAI ASAM	0.272	47	TEBING	0.262	67	KAPLING	0.252
8	PULAU MORO	0.354	28	TANJUNG BATU BARAT	0.272	48	TULANG	0.261	68	HARJOSARI	0.252
9	NGAL	0.342	29	MORO	0.272	49	TANJUNG BERLIAN BARAT	0.261	69	PAMAK	0.252
10	SUNGAI BULUH	0.340	30	TANJUNG BALAI KOTA	0.271	50	TANJUNG BATU KECIL	0.260	70	PANGKE BARAT	0.252
11	TANJUNG BATU KOTA	0.329	31	SELAT MIE	0.270	51	SUGIE	0.259	71	GADING SARI	0.252
12	SELAT MENDAUN	0.322	32	TELUK UMA	0.269	52	SAWANG SELATAN	0.259			
13	PERAYUN	0.317	33	PARIT BENUT	0.269	53	ALAI	0.258			
14	BARAN BARAT	0.315	34	PENARAH	0.268	54	KUNDUR	0.258			
15	NIUR PERMAI	0.301	35	TANJUNG BERLIAN KOTA	0.267	55	LUBUK SEMUT	0.258			
16	GEMURUH	0.293	36	MERAL KOTA	0.266	56	TANJUNG KILANG	0.258			
17	KEBAN	0.292	37	SANGLAR	0.265	57	TANJUNG HUTAN	0.257			
18	TELUK RADANG	0.291	38	BURU	0.265	58	TANJUNG BALAI	0.256			
19	LEBUH	0.285	39	MORO TIMUR	0.265	59	SUNGAI UNGAR	0.256			
20	LUBUK PUDING	0.284	40	PANGKE	0.264	60	SAWANG LAUT	0.255			

Figure 3. The Result from FMADM with Priority

5. Conclusion

Implementation of FMADM to determine priorities in the research is effective process. Using variables such as numbers of households, medium enterprises, GRDP, and economic growth rates can assist to rank in distribution priority. FMADM, allowing weight changes to gain significant results. Result obtained is 7% (5 villages) with high priority, 62% (44 villages) with medium priority, and 31% (22 villages) for low priority. It can be easily determine, which district to get first distribution. Impact of executing Fuzzy MADM is more effective than conventional method. Time and needs can be considering in process. Advantage of Fuzzy MADM is that calculating is worked by small numeric and it is influence in computing numeric value in hardware. Conversely, conventional method is using true value. It can cause calculating run slow and create waste the time.

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