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Adaptive FANP And TOPSIS Method For Innovation Strategy Of Small Medium Enterprise (SME)

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ABSTRACT
This study aims to determine the assessment and innovation strategy of SMEs based on the hybrid adaptive method of Fuzzy Analytic Network Process (FANP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). The advantage of the FANP method is the can handle data that contains uncertainty. Some of the measurement indicators of SMEs are qualitative, so the Fuzzy method is needed to make decisions easier. Adaptive methods make decision-making more flexible because decision-makers can determine their own linguistic scale to get optimal results. The adaptive Fuzzy ANP method is used to determine the weight of each measurement indicator in SME, while the TOPSIS method is used to rank SME. The weighted Normalization in the TOPSIS method is determined based on the results contained in the FANP so that by integrating the two methods can result in better decisions and high flexibility. The results of this research is the Framework and a priority assessment indicators of Innovation Strategy Map (ISM) of SME.

Keywords : Adaptive Fuzzy Analytic Network Process (FANP), SME, Assesment, Innovation, TOPSIS, Stategy Map.

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I. INTRODUCTION

SMEs are business activities that are able to expand employment and provide widespread economic services to the community and play a role in the process of equity and increasing public income, encourage economic growth, and play a role in realizing national stability. In addition, Micro, Small and Medium Enterprises are one of the main pillars of the national economy which must have the ultimate opportunity, support, protection and broadest development as a manifestation of firm decisiveness to the group of people's economic enterprises, without neglecting the role of Big Enterprises and Business Entities State Owned.

Small and Medium Enterprises (SMEs) have a strategic role in building the national economy and also play a role in the distribution of development results. The development of SMEs needs to be gained great attention both from government and society in order to grow more competitive with other economic actors. Each SME is required to improve in every aspect of its performance so that SMEs can survive and exist in competition with other SMEs.

Business competition is one of the SME performance measurement factors. An SME that moves with a high level of risk, primarily at the risk of loss of SMEs. There are several criteria for the assessment of the performance of SMEs namely employee training, owner education, owner training, net income, sales transactions, ownership (shop), variations of batik motifs, raw material price increases, weather conditions, production, customer market, customer complaints, the preferred, and customer satisfaction. The number of criteria in the assessment of SME performance hence required a method of multi-criteria decision making (MCDM). MCDM is a method used to determine the criteria weighting of some alternatives based on the judgment of a person or several persons. This Multi-criteria method can also be used as a method in decision support system (DSS).

DSS is an interactive computer-based system, which can assist decision-making in utilizing data and models to solve unstructured problems [1]. MCDM methods used in the SPK include FAHP, ANP, TOPSIS, FTOPSIS, and DEMATEL [2]. In this study, the MCDM method is less effective for dealing with data containing uncertainty and uncertainty. In this study, the criteria that influence the results of SME products based on predetermined criteria using Fuzzy Analytic Network Process (FANP) method approach.

This method can be used to solve the problem of decision-making in which there is interrelation relationship between criteria in a certain

level. This is particularly suited for this decision support system because of the many criteria that need to be considered in performance appraisal, where the criteria for carrying out judgments are inter-related to one another [3]. This approach is used to make the best decision based on the existing criteria, both qualitative and quantitative. The use of Fuzzy in this study to accommodate the vague nature of decision-making to give consideration that can overcome the uncertainty in qualitative criteria [3]. The advantages of the TOPSIS method are representing the logic of human choice, the unique visualization for several alternatives, the existence of the best and worst alternative choices simultaneously, a simple calculation process [4,5].

The motivation for FANP integration with TOPSIS is TOPSIS using the concept of a positive ideal solution and the ideal negative solution in the determination of alternatives; use of TOPSIS after FANP avoids indicators that can accurately; previous studies that used the integration of this method were Performance measurement SME, marketing strategy evaluation, hospital location planning; and evaluation machine tool [4,6,7,8,9]. The purpose of this study is to propose an SME rating framework that has several different characteristics. The benefits of the proposed Framework are to assist SMEs in Bangkalan in determining SME's long-term and short-term strategies, facilitating SME Co-operatives in working with SMEs, increasing SME revenue and accelerating decision-making appropriately and correctly. By combining FANP, and TOPSIS methods, make better decisions in determining innovation strategies and SME performance measures. The difference with other research is the concept of adaptive in this research so that makes the decision have high flexibility in determining the optimal decision.

II. LITERATURE REVIEW

2.1. Fuzzy Theory

The Fuzzy membership function is a degree of proximity an object to a particular attribute. A fuzzy number is represented by a set representing an uncertain quantity and estimating degree membership of each value in a subset. Definition of set Fuzzy A if X is a collection of objects denoted by x, then a set of Fuzzy A in X is a set of consecutive pairs [10,11],

$$A = \left\{ (x, \mu_A(x)) \mid x \in X \right\} \quad (1)$$

where $\mu_A(x)$ is a degree of membership x that maps X to the interval [0,1]. Membership Function (MF) or the degree of membership is a curve showing the mapping point of data input into the value of membership.

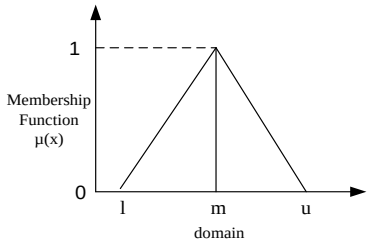

Figure 2.1. Triangular Fuzzy Number

Fuzzy Membership Function [10]

$$\mu(x) = \begin{cases} 0; & Otherwise \\ (x-l)/(\mathrm{m}-l); & l \le x \le m \\ (\mathrm{u}-x)/(\mathrm{u}-m); & m \le x \le u \end{cases}$$

2.2. FUZZY ANP

The ANP is a generalization of the AHP [12]. AHP has represented a framework with a uni-directional hierarchical relationship, ANP allows for complex inter-relationships among decision levels and attributes. The ANP give a feedback approach with networks in which the relationships between levels are not easily represented as higher or lower, dominant or subordinate, direct or indirect [13]. Based Chang each object of criteria and sub-criteria to be considered and extend the analysis to obtain a goal executed. This means it is possible to obtain the analysis which can extend the value indicated by the notation as follows [14].

$$M_{gi}^{1}, M_{gi}^{2}, M_{gi}^{3}, M_{gi}^{4}, M_{gi}^{5} \ldots M_{gi}^{m} \quad (2)$$

Set as a goal (1,2,3,…,m), and M_{gi}^{j} (j = 1,2,3,...,m) are Triangular Fuzzy Number, after identifying initial assumptions, extend the analysis of Chang can be described with the following stages:

1. Decision Modeling with fuzzy ANP by specifying criteria and sub-criteria.
2. Development B pairwise comparison matrix between all the elements / criteria, sub-criteria of the fund each dimension criteria in a hierarchical system based on an assessment of linguistic variables.

$$B = \begin{bmatrix} & C_1 & C_2 & C_3 & \ldots & C_n \\ C_1 & 1 & b_{12} & b_{13} & \ldots & b_{1n} \\ C_2 & b_{21} & 1 & b_{23} & \ldots & b_{2n} \\ C_3 & b_{31} & b_{32} & 1 & \ldots & b_{3n} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ C_n & b_{n1} & b_{n2} & b_{n3} & \ldots & 1 \end{bmatrix}$$

Figure 2.2. Pairwise Comparison Matrix

Where

n = number of criteria to be evaluated
Ci = i. Criteria
bij = interests of i. criteria based j

3. Normalization Matrix, determine the consistency value of the index, if Consistency Ratio (CR) <= 0.1 then proceed to step number 4, otherwise it will be re-quisioner.
4. Change the linguistic variables in the form of fuzzy numbers. Questionnaire data in the form of linguistic variables fuzzy numbers are converted to forms. TFN Chang fuzzy numbers to be seen (the scale of the fundamental interests of Relative ANP) with a different level of importance.
5. Enter the search criteria and the weighting formula contained in steps as follows :

a. Determining the value of synthetic extend (the) associated with the object to i then represented as follows

$$si=\sum_{j}^{m}=1\, M_{gi}^{j} \quad \otimes \quad \left[\sum_{j=1}^{n} \sum_{j=1}^{m} M_{gi}^{j}\right]^{-1} \quad (3)$$

To get this $M_{gi}^{j} \sum_{j-1}^{m}$ done adding fuzzy operation of m with particular matrix $\sum_{j=1}^{m} M_{gi}^{j}=\left[\sum_{j=1}^{m} L_{j}, \sum_{j=1}^{m} m_{j}, \sum_{j=1}^{m} u_{j}\right]$ (4)

To get $\left[\sum_{j=1}^{n} \sum_{j=1}^{m} M_{gi}^{j}\right]^{-1}$
surgery fuzzy value from (j = 1,2,3....m)

$$\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^{j}=\left(\sum_{j=1}^{n} l_{j}, \sum_{i=1}^{n} m_{j}, \sum_{i=1}^{n} u_{j}\right) \quad (5)$$

At the end of the first step of the determinant of the inverse vector

$$\left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^{j}\right]^{-1}=\left(\frac{1}{\sum_{i=1}^{n} u_{i}}, \frac{1}{\sum_{i=1}^{n} m_{i}}, \frac{1}{\sum_{i=1}^{n} l_{i}}\right)$$

(6)

b. Determining the degree of likelihood (degree of possibility) and fuzzy set m2 = (l2, m2, u2) ≥ M1 = (L1, M1, U1) is defined as V (m2 ≥ M1) = supy≥x [min (μm1 (x), μm2 (y))]
x and y are the value on the axis of each membership function. Applied to the theory and applications of fuzzy TFN with 3-type of low, medium and upper (l, m, u) and membership functions have been formed with the following equation :

$$V(m_2 \geq m_1) = hgt(m_1 \cap m_2) = \lambda\, m_2(d)$$

$$V(m_2 \geq m_1)=\begin{cases} 1, & if\ m_2 \geq m_1 \\ 0, & if\ l_1 \geq u_2 \\ \dfrac{l_1-u_2}{(m_2-u_2)-(m_1-l_1)} & otherwise \end{cases} \quad (7)$$

c. Determining the degree of likelihood for Confex fuzzy number is greater than k at Confex fuzzy number for Mi = (i = 1,2,...,k) can be defined as:
V = (M ≥ M1, M2,..., Mk)
= V [(M ≥ M1)] and [M ≥ M2] and (M ≥ Mk)]
V = min (M ≥ Mi)
It is assumed that d` = min V (Si ≥ Sk)
For k = 1,2, ..., n k ≠ i then the weight vector used
W` = (d` (Ai), d` (A2), d` (A3), ..., d` (An)) T
Where Ai (i = 1,2,3, ..., n) is an element n

6. Through normalization, weighting vector normalization
W` = (d (A1), d (A2), ..., d (An)) T
Where we are nonfuzzy numbers.
7. Determination of global sub-criteria weights matrix by multiplying matrix interdependence with WT2 (weighted sub-criteria)
8. Measurement of sub-criteria using linguistic variables by multiplying the weight of global (global weight) with a value scale (scale value) each sub-criteria.
9. Consistency test is done by looking at the value of l, m and u. Value $l \leq m \leq u$ shows fuzzy consistent ratings. Fuzzy comparison matrix that consists of two dimensions, consistency index are always consistent.

III. RESEARCH METHODS

3.1. Modeling Stage.

This stage is the stage of identification of MCGDM problem by determining the number of variables that will be used in the research. This variable consists of criteria, alternatives, appraisers, and respondents. The criteria used in this research are employee training, owner education, owner training, net income, sales transaction, ownership (shop), a variation of batik motiveLe, raw material price increase, weather condition, production, customer market, customer complaint, preferred, and customer satisfaction. This stage can be seen in Figure 1. Criteria And Sub Criteria Of SME

3.2. Weighting Stage

Weighting is an assessment of all criteria by the owner and the SME service based on pairwise comparisons to create a decision matrix. The method used is FANP, this step consists of several steps that are to determine the scale of criteria assessment, determine the membership function, determine the average matrix, and calculate the synthetic extend.

3.3. Ranking Stage

This stage is an alternative ranking based on the weighting contained in stage 3.2. The stage is done using TOPSIS method. The result of TOPSIS method is alternative ranking and SME innovation strategy.

3.4. Simulation and Analysis.

This stage is done to test the Hybrid FANP and TOPSIS models using SME data. The results of this stage to find out the results weight each indicator and alternative optimal solutions of SME innovation strategy.

All stages in this research method can be seen in Figure 1. Framework Assessment and Innovation Strategy of Small Medium Enterprise (SME)

IV. RESULTS AND DISCUSSION

4.1. System Description

This system is designed to assist the cooperative department and the owners of SMEs in making decisions to minimize the occurrence of a risk to SMEs. This system will assess the priority of feasibility based on the weight and mapping of SMEs using hybrid methods of FANP and TOPSIS. The system consists of 2 users, the admin and the owner of SME, all the activities of the system can be seen in the diagram contained in Figure 2. Use Case measurement and mapping SMEs. There are 3 questionnaires in this study that is a questionnaire of interest and questionnaires of the relationship between criteria filled by the owners of SMEs and the Office of Cooperative SMEs. The design of this SMEs rating decision support system software was created with the aim of facilitating the owners of SMEs to identify the occurrence of losses on SMEs.

Table 1. *Triangular Fuzzy Number (TFN) Scale And Linguistic Variables Scale Conversion*

Linguistic Scale	Values interest	TFN Scale	TFN inverse scale
Equally important	1	(1,1,1)	(1,1,1)
A little more important	3	(1,3,5)	(1/5,1/3,1/1)
More important	5	(3,5,7)	(1/7,1/5,1/3)
Very important	7	(5,7,9)	(1/9,1/7,1/5)
The most important	9	(7,9,11)	(1/11,1/9,1/7)

4.4. Simulation and Analysis

The steps of phase simulation and analysis:

1. Determine the scale of the alternative assessment. Determine the linguistic preference scale of the linguistic for the respondent. Definitions of linguistic variables for the importance is shown in Table 1.
2. Determine the data criteria and sub-criteria of SMEs, assessment matrix comparison in pairs for criteria and sub criteria by the cooperative service, as in tables 2 and 3.

Table 2. *Pairwise Matrix For SME Criteria*

Criteria	Learning and Growth	Business Internal	Customer
Learning and Growth	1	5	7
Business Internal	0.2	1	3
Customer	0.14	0.33	1

3. Construction of normalized decision matrix. After the group assessment data are obtained then the data is normalized to eliminate Duplicate data, reduce complexity and facilitate data modification.
4. Construction of weighted normalization matrix, as shown in Table 4.

Table 4. *The Result Of Criteria Weight*

A1	A2	Owner	Service	A5
0.07625	0.1045	0.13454	0.10817	0.01277
Motives of interest	B2	B3	B4	Weather conditions
0.10576	0.02543	0.02883	0.02129	0.18311
The price of basic materials	C1	Customer Market	C3	
0.26338	0.13178	0.24514	0.12912	

5. Results SME mapping based on hybrid method fuzzy ANP and TOPSIS is shown in Table 5.

Table 5. *The Results Of SME Mapping*

Name SME	Value TOPSIS	Mapping Results
SME 1	0,878	Good
SME 2	0,807	Good
SME 3	0,477	Improve
SME 4	0,678	Good
SME 5	0,988	Good
SME 6	0,498	Improve
SME 7	0,784	Good
SME 8	0,567	Improve
SME 9	0,974	Very Good
SME 10	0,922	Very Good

Based on the results of the experiment on Table 5. The Results Of SME Mapping, the hybrid method accelerates the mapping process of SME, so as to

minimize the occurrence of losses in each SME. The graph of mapping SME is shown in figure 4.

V. CONCLUSIONS

Based on this research, that by using adaptive FANP method, decision maker can determine value scale scale appraisal flexibel to determine the optimal criterion. By performing hybrid method between Adaptive Fuzzy ANP and TOPSIS, giving advantages in normalization of weighted in TOPSIS method, this is because criterion assessment is more objective because based on importance level. The results of the hybrid method provide convenience to the Department of Cooperatives in Mapping SMEs, so as to reduce the risk of large losses in each SME. further research can be developed into an Adaptive Interval Value Fuzzy ANP.

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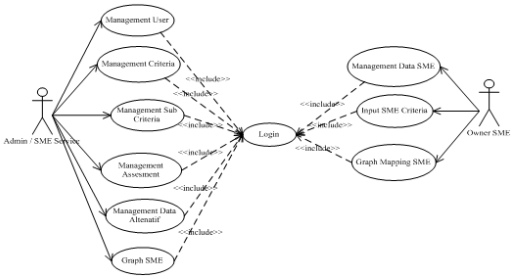

Figure 2. *Use Case Diagram Assesment And Innovation Strategy Map SME*

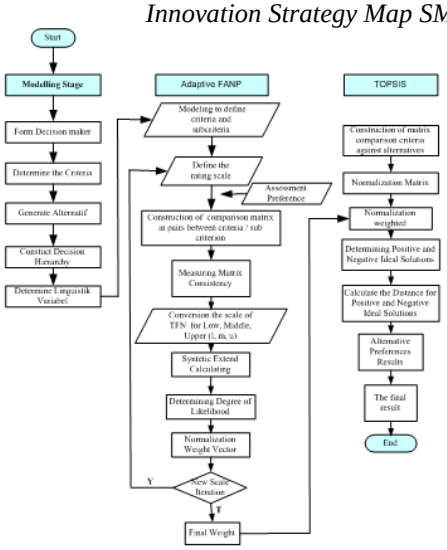

Figure 1. Framework Assesment and Innovation Strategy of Small Medium Enterprise (SME)

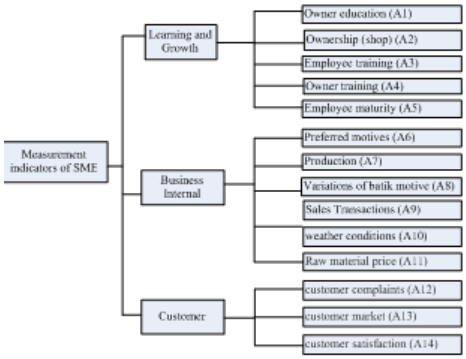

Figure 3. Criteria And Sub Criteria Of SME

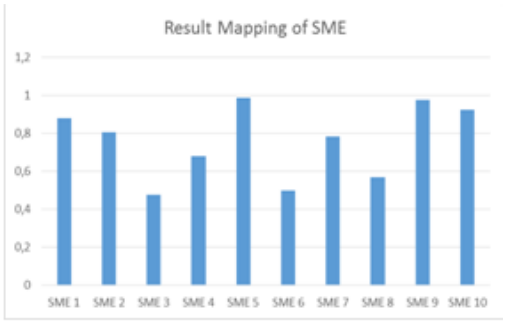

Figure 4. The graph of mapping SME

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