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	<b>Title:</b>	FCM-BPSO: ENERGY EFFICIENT TASK BASED LOAD BALANCING IN CLOUD COMPUTING
	<b>Author:</b>	GEETHA MEGHARAJ, DR. K. G. MOHAN
	<b>Abstract:</b>	Virtual machine (VM) migration is a methodology used for attaining the system load balancing in a cloud environment by transferring the one VM from one physical host to another host. In this paper, we plan to migrate the extra tasks from overloaded VM to suitable VM instead of migrating the entire overloaded VM. In order to select the host VMs, a FCM clustering algorithm has been used to group the similar kind of host VMs. Once the VMs identified as overloaded, then the corresponding candidate VMs are found using the FCM clustering algorithm. Binary Particle Swarm Optimization (BPSO) methodology has been used for selecting the host VMs from the set of candidate VMs based on multi-objective fitness function, which includes task transferring time, task execution time and energy consumption. By allocating the extra task from the overloaded VMs to the proper VMs, we achieved the load balancing in the cloud environment. The implementation of proposed methodology FCM-BPSO has been done using CloudSim tool and comparative analysis done to evaluate the FCM-BPSO method with a traditional load balancing algorithm in terms of energy consumption and time.
	<b>Keywords:</b>	Load Balancing Algorithm, Task Scheduling, Particle Swarm Optimization, Fuzzy C Means, Clustering
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# INTEGRATION BALANCED SCORECARD AND FUZZY ANALYTIC NETWORK PROCESS (FANP) FOR MEASURING PERFORMANCE OF SMALL MEDIUM ENTERPRISE (SME)

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## Abstract

The purpose of this research is to determine the standards or uniformity performance measurement indicators SMEs in accordance with needs and conditions in Bangkalan Indonesia, Constructing and building decision models with multi-criteria decision making (MCDM) by a hybrid between the method of the balanced scorecard (BSC), fuzzy analytic network process (FANP), and technique for order preferences of similarity ideal solution (TOPSIS), Implementation of multi-criteria decision making (MCDM) to Determine the performance measurement SMEs in Bangkalan Indonesian. The research is based on three main ideas; the first is a fuzzy logic approach due to the complexity and lack of clarity in the assessment criteria for performance measure indicators. The second is to measure the overall performance according to the balanced scorecard perspectives, namely customer, financial, internal business, learning, and growth. The third is to rank all criteria weighted using Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method. Based on the integration of three methods: fuzzy ANP, Balanced scorecard, and TOPSIS, this way it makes better decisions in this process.

**Keyword :** *Integration, Fuzzy ANP, Balanced Scorecard, Perspectives, Assessment.*

## 1. INTRODUCTION

Bangkalan city in Indonesian has a very good potential as an engine of regional economic growth as well as unemployment and poverty alleviation aspects, this is due to the rapid development of SME is around 125 thousand. Based on the data center and the Ministry of Cooperatives statistics, in 2003, the number of small and medium enterprises (SME) recorded 42.39 million units or 99.9% of total business, absorbing about 79.04 million workers, or 99.4% of the total labor force that works. SME contribution to Gross Domestic Product (GDP) is quite significant, amounting to 56.72% of the Gross Domestic Product (GDP), (Bank Indonesia, 2006). Small and medium enterprises (SMEs) in Indonesia are a basis for economic development, because of the large number of SMEs and proved resilient despite the economic crisis [1]. The Productivity of SME is one of the important factors which influenced the course of progress of SME. Increased productivity together with the improved performance of an organization in SME. Number of SMEs leading to difficulties in determining the cooperative business strategies of SMEs and mapping of the creative industries.

Therefore it is necessary to measure the performance of all aspects of the overall SME to determine what factors should be done for the development and progress of the business. The performance measurement consists of many criteria (Multi Criteria Decision Making / MCDM). Multi-Criteria Decision Making (MCDM) is very suitable for the selection of attributes or criteria within the various levels of hierarchy within an organization and used for priorities that attribute [2].

In this research, the performance measurement is using Fuzzy Analytic Network Process (FANP). Fuzzy logic is in accordance with the needs in solving complex problems and ambiguities contained in the concept of measurement, which is inherent in the nature of the concept of competition [3]. In the conventional method of decision-making on multi-criteria decision making (MCDM) is represented as an exact figure. However, in many practical cases, according to Zhang for data containing the vagueness, uncertainty, and imprecision, decision makers can not assign exact numerical values for evaluation[4]. Fuzzy set theory is suitable for this purpose, because by using fuzzy set theory, the decision-making process can be carried out within the framework of a



more flexible, individual elements or criteria have a degree of membership that is described by the membership function  $[0,1]$  [5]. Excess fuzzy in addition to more flexible, among others able to model non-linear function is very complex, are tolerant of incorrect data as passable, a bit [6]. Fuzzy Analytic Network Process (FANP) in the excess presence of consideration interactions in a reciprocal relationship between the indicators, the dependence between criteria with sub-criteria that are based on examination of the dependency and produce weight [3]. Fuzzy Analytic Network Process (FANP) has the ability to measure the qualitative and quantitative indicators by comparing the weight of a priority among many key performance indicators. Fuzzy approaches are used for complex problems and uncertain, so that decision makers difficulty in determining the decision, usually using intuition and subjectivity itself, by using fuzzy cause decision-makers to assess the individual criteria and alternatives more objectively, so that decisions are more accurate [7]. The fuzzy logic technique is very effective and has a computational intelligence to deal with the uncertainty of reasoning in the decision-making based on the variables used [8]. Criteria of performance measurement are determined based on data drawn from the department of cooperative SMEs and direct survey to some SMEs, identification of stakeholders. Their conventional measurement in SMEs is also used as a basis for determining the criteria or indicators in this research. Those criteria are finance, production processes, and human resources management. Criteria of performance measurement have classified using the balanced scorecard. Balanced scorecard (BSC) used for very high efforts in aligning business strategy into four perspectives [9]. In this research, using a balanced scorecard approach, where the excess is related to his efforts to translate the organization's mission and strategy into four perspectives: customer; Internal business; learning and growth; and financial business [9] [10] [11]. The customer perspective consists of the level of service satisfaction (LS), Satisfaction levels for the facility (SL), the customer retention rate (SC). Internal business perspective is consists of the number of new products (NP), Variation Batik (VB), Weather Conditions (WC), Transaction Sales (TS), Production (P), Total manpower (TM). Learning and growth perspective are consist of The satisfaction of employees (SE), the Average service life of employees (AS), Amount of training education owner (AT), The owner training (OT), Employee training (ET), Owners (Shop) (OW).

Financial perspective is consist of Net Income (NI), Current Ratio (CR). Based on all of these perspectives, then all the indicators specified for measuring performance. Fuzzy Analytic Network Process (FANP) used for weighting indicators in performance measurement, while balanced scorecard is determined the classification indicator. All methods are intended for the evaluation and selection of performance measurement to the concept of multi-criteria decision making (MCDM). Currently, the main focus of performance measurement is only the financial activities without considering other elements such as human resources or internal business. The Balanced scorecard is a method for measuring the overall performance includes four perspectives, namely consumer, financial, growth and development and internal business [10] [11]. Performance measurement SME in Indonesia yet thorough based indicators in the balanced scorecard so that the analysis results of the measurements have not done thoroughly. This research approach integrating balanced scorecard method and fuzzy Analytic Network Process (FANP). Balanced Scorecard method for the classification criteria into four perspectives, then weighted using fuzzy Analytic Network Process (FANP), criteria for ranking using TOPSIS method. TOPSIS is a multi-criteria method to determine the solution of a group of limited alternatives for Performance rating and weighting of the criteria, the selected alternative is to have the shortest distance from the positive ideal solution and the farthest distance from the negative ideal solution [12].

The purpose of this research is to determine the standards or uniformity performance measurement indicators SMEs in accordance with needs and conditions in Bangkalan Indonesia, Construct and build decision models with multi-criteria decision making (MCDM) by a hybrid between the method of the balanced scorecard (BSC), FANP, and technique for order preferences of similarity ideal solution (TOPSIS), Implementation of multi-criteria decision making (MCDM) to Determine the performance measurement SMEs in Bangkalan Indonesian. The significant contribution of this research is to knowledge in educational and scientific aspects in the field of decision support system for multi-criteria decision making (MCDM) to develop the concept of fuzzy sets, hybrid method with the balanced scorecard, Fuzzy ANP, and TOPSIS to implement the multi-criteria decision-making problems of SMEs with some criteria or indicators are difficult to measure. Contributions for a cooperative department is able to produce a standard

application in determining the weight of the SME indicator that helps agencies Cooperatives in determining future innovation strategy and mapping industry creative SMEs. Score fuzzy Analytic Network Process (FANP) weights used to define the innovation strategy and SWOT analysis (Strength, Weakness, Opportunity, Threat) of SMEs. Based on the weight of each SME indicators for mapping the creative industries and define innovation strategies for SME development in Bangkalan Indonesian. The problem in the research, how to determine the KPI (key performance indicators) in the measurement of performance in SMEs, construct and build decision models multi-criteria decision making (MCDM) with hybrid method BSC, FANP, and TOPSIS for implement to measure the performance of SMEs in Indonesian.

**2. LITERATURE REVIEW**

**2.1. Analytic network process**

Analytic network process (ANP) is a generalization of the analytic hierarchy process (AHP). AHP is a framework with hierarchical relationships unidirectional while the ANP for the complex interrelationship between the decision level and attributes. ANP method uses the concept of network relationships to solve the problem of dependency between alternatives or criteria that is higher or lower, dominant or subordinate, directly or indirectly [13], ANP is used for multi-criteria decision making (MCDM) problems [14]. This research integrates the model of fuzzy MCDM (multicriteria Decision Making) by combining fuzzy Decision Making Trial and Evaluation Lab Model (DEMATEL), ANP (Analytic Network Process) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). This study aimed to evaluate the supplier in accordance with the specifications of the company, which GSCM (green supply chain management) as a framework to determine KPI (key performance areas) [15], the following study her with the same old methods of using the third combination of methods FDAMATEL, FANP FTOPSIS for innovation and decision-making of higher education in Taiwan [6].

Subsequent research aimed at building a framework to support supplier selection process in Iranian Automotive Industry. This study uses Fuzzy ANP for weighting the measurements and determining the level of the most important among the criteria. The model is implemented helps companies Automotive for selecting suppliers. This study uses NGT (nominal Technic Group) to summarize critical success factor (CSF), FANP for

weighting the criteria selected. As for selecting suppliers use a checklist rating total score [17].

Enterprise architecture planning is a methodology that looked at elements within the enterprise as a whole, where the EAP will define the architecture for the use of information in support of business and plans to implement the architecture within a company / organization. Research enterprise architecture planning is based on the stage of strategic information planning, performance measurement (balanced scorecard) using AHP and system integration [18].

**2.2. Fuzzy Membership Function**

Membership Function (MF) or the degree of membership is a curve showing the mapping point of data input into the value of membership. One way that can be used to obtain the membership value is through the approach function. The functions used in this study curve which is essentially a combination of two lines (linear) as shown in Figure 2.1.

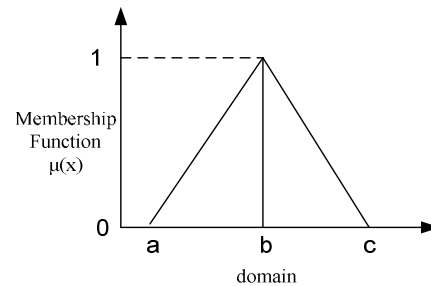


Figure 2.1. Triangular Fuzzy Number Fuzzy Membership Function [19]

$$\mu(x) = \begin{cases} 0; & \text{Otherwise} \\ (x-a)/(b-a); & a \leq x \leq b \\ (c-x)/(c-b); & b \leq x \leq c \end{cases} \quad (1)$$

**2.3. Fuzzy Analytical Network Process (FANP)**

Fuzzy ANP method is applied for an extension of the AHP and ANP by combining the fuzzy set theory. In the ANP Fuzzy, Fuzzy ratio scale used to indicate the relative strength of the factors on which the relevant criteria. The fuzzy decision so that a matrix can be formed. Kahit of alternatives are also presented in the Figures Fuzzy [13]. Based Chang each object of each-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 [20, 21, 22].

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



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

1. Development a 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.

$$A = \begin{bmatrix} & C_1 & C_2 & C_3 & \dots & C_n \\ C_1 & 1 & a_{12} & a_{13} & \dots & a_{1n} \\ C_2 & a_{21} & 1 & a_{23} & \dots & a_{2n} \\ C_3 & a_{31} & a_{32} & 1 & \dots & a_{3n} \\ \vdots & \vdots & \vdots & \vdots & \ddots & \vdots \\ C_n & a_{n1} & a_{n2} & a_{n3} & \dots & 1 \end{bmatrix}$$

Figure 2.2. Pairwise Comparison Matrix

Where

$n$  = number of criteria to be evaluated

$C_i = i$ . Criteria

$A_{ij}$  = interests of  $i$ . criteria based  $j$

2. 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.

Table 2.1. Triangular Fuzzy Number (TFN) Scale And Linguistic Variables Scale Conversion

Linguistic Scale	Values interest in AHP	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)

3. Enter the search criteria and the weighting formula contained in steps - steps as follows [25] :

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

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

To get this  $M_{gi}^j \sum_{j=1}^m$  done adding fuzzy operation of  $m$  with particular matrix

$$\sum_{j=1}^m M_{gi}^j = \left[ \sum_{j=1}^m L_j, \sum_{j=1}^m m_j, \sum_{j=1}^m u_j \right] \quad (4)$$

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

$$\sum_{i=1}^n \sum_{j=1}^m M_{gi}^j = \left( \sum_{j=1}^n l_j, \sum_{i=1}^n m_j, \sum_{i=1}^n u_j \right) \quad (5)$$

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  $m_2 = (l_2, m_2, u_2) \geq M_1 = (l_1, m_1, u_1)$  is defined as

$V(m_2 \geq M_1) = \text{supy} \geq x [\min(\mu_{m_1}(x), \mu_{m_2}(y))]$   $x$  and  $y$  is 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 :

$$V(m_2 \geq m_1) = \text{hgt}(m_1 \cap m_2) = \lambda_{m_2}(d)$$

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

4. Determining the degree of likelihood for Confex fuzzy number is greater than  $k$  at Confex fuzzy number for  $M_i = (i = 1,2,\dots,k)$  can be defined as:

$$V = (M \geq M_1, M_2, \dots, M_k) = V[(M \geq M_1)] \text{ and } [M \geq M_2] \text{ and } [M \geq M_k]$$

$$V = \min(M \geq M_i)$$

It is assumed that  $d' = \min V(S_i \geq S_k)$

For  $k = 1,2, \dots, n$   $k \neq i$  then the weight vector used

$$W' = (d'(A_1), d'(A_2), d'(A_3), \dots, d'(A_n)) T$$

Where  $A_i$  ( $i = 1,2,3, \dots, n$ ) is an element  $n$

4. Through normalization, weighting vector normalization

$$W' = (d(A_1), d(A_2), \dots, d(A_n)) T$$

Where we are nonfuzzy numbers.

5. Determination of global sub-criteria weights matrix by multiplying matrix interdependence with WT2 (weighted sub-criteria)

6. Measurement of sub-criteria using linguistic variables by multiplying the weight of global (global weight) with a value scale (scale value) each sub-criteria.

7. 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

**2.4. Balanced Scorecard**

Balanced Scorecard is a management tool that consists of a series measurements that can provide a quick but thorough overview of the organization’s performance in terms of both financial and non-financial [23]. The Balanced Scorecard is a set performance and approach to performance measurement that stresses meeting all the organization’s objectives relating to its critical success factors. Framework of the balanced scorecard is divided into four perspectives: customer, internal business, learning and growth, financial. (Figure 2.3.) as follows [10,11].

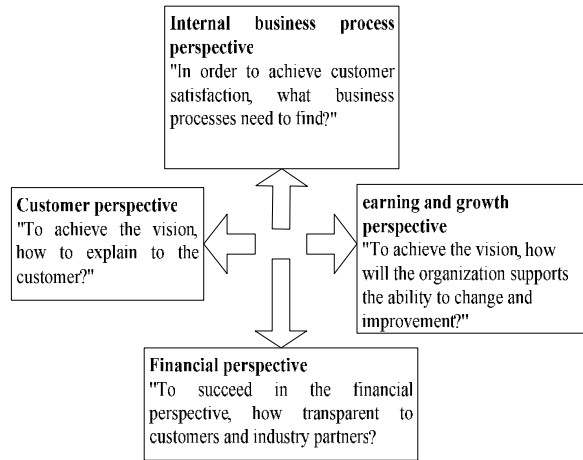


Figure 2.3. Balanced Scorecard Framework [10]

**2.5. TOPSIS**

TOPSIS method is based on the concept that the alternative chosen should have the shortest distance from the positive-ideal solution and the longest distance of the negative-ideal solution. TOPSIS define an index called the similarity with positive-ideal solutions and the remoteness of the negative-ideal solution. Then the method of choosing the alternative with the maximum similarity to positive solutions-ideal [24]. Increasing number of factors that must be considered in the decision-making process, it is increasingly difficult to take a decision on an issue. Moreover, if the decision-making efforts of a particular problem, in addition to considering various factors / criteria vary, also involves some decision makers. Problems are thus known to the problems of multiple criteria decision making (MCDM). In other words, MCDM also be referred to as a decision to choose the best alternative from a number of alternatives based on certain criteria. TOPSIS method is used as an attempt to solve the problems of multiple criteria decision making. This is due to the concept is simple and easy to understand, computationally efficient and has the ability to measure the relative performance of the alternatives decision.

**3. RESEARCH METHODS**

**3.1. Preparation phase**

**Identification Phase, Problem Formulation and research purposes.**

The initial stage is reached in the running study is to formulate the problem of how to build applications using FANP MSME productivity measurement.

**Survey, data collection, Literature, and reviewed journals.**

This stage is to seek, learn and use a wide range of literature in the form of books, journals, papers, e-book, book, or other literature related to Decision Support system, indicators weighting system with fuzzy ANP.

**3.2. Data processing stage**

**Analysis of system requirements**

Needs Analysis system is the identification system to be built. That will be done to identify the picture of the new system is to make observations (observation), then to identify software needs

**System planning**

At this stage of system design is done use the Unified Modeling Language (UML), which is designing Use Case diagrams, Activity diagrams, sequence diagrams, design database (Conceptual Data Model / CDM and Physical Data Model / PDM) and flowchart (Figure 4.2) and user interface design.

**Implementation of the system**

This stage is to make modeling with building applications MSME productivity measurement. Which comprises the KPI input from each perspective, weighting each criterion, until the results of analysis of the conditions of SMEs so as to define the innovation strategy, mapping and



provide recommendations for improvement of MSEs.

**3.3. Stage Trial System and analysis**

**Research Data :**

Implementation test these applications using respondent questionnaire data propagated a certain period, as well as interviews with the cooperatives and SMEs. Before the questionnaire data is used, first tested the validity to determine the feasibility of the research data.

**Scenario Trial**

Based on data from the results of the questionnaire, conducted trials that by combining the results of questionnaires according to the indicators or criteria and weighting by FANP. The results will be made to determine the ranking and analysis of the productivity of SMEs.

**Analysis Results**

After knowing the score of each sub-criteria, calculate SWOT next is to determine the condition of the organization's performance

**4. RESULTS AND DISCUSSION**

**4.1. Description System**

The system is designed in this study is the performance appraisal system on SMEs based on the classification of each criterion using the Balanced Scorecard (BSC) with four perspectives: customer, financial, internal business, learning, and growth. The software can help small business owners in making decisions to minimize the occurrence of a risk on SMEs. This system will provide an assessment of the feasibility of priority based on weight, rank and value using methods FANP, whereas to determine the ranking criteria using TOPSIS. The overall model of performance measurement in the SME can be seen in Figure 4.1. Based on the Figure 4.1. Shown that the expert / decision maker to respond to determine to the classification criteria of the balanced scorecard (Figure 4.3.), the followed expert / decision maker provides an assessment of the ratings in the range of fuzzy used for weight determination. If the weight of each criterion is already known to the rankings and SWOT determination can be determined. The system, there are three questionnaires, the questionnaire scale questionnaire interests and linkages between the criteria required by the owners of SMEs and Cooperatives and SMEs Bangkalan Indonesian where are risk assessment questionnaire standards set by the Department of Cooperatives and SMEs Bangkalan Indonesian.

The results of the questionnaire will be processed to Determine the criteria influencing the risk of losses on SMEs. The Weights obtained by using fuzzy ANP according to flowchart below (Figure 4.2.), while the comparison value is determined by the respective owners of SMEs. Based on the Figure 4.2. explained that for weighting using FANP starting from determining the scale of comparison criteria. Then convert the scale TFN or membership functions fuzzy numbers, continued counting fuzzy synthetic and determine the degree of likelihood, if  $m_2 \geq m_1$  then  $V = 1$ , and if  $l_1 \geq u_2$  then  $V = 0$  or if the value of  $V$  excluding both,

$$V = \frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} \quad (6)$$

Then to determine the minimum value and determine the weight vector, determine the normalized vectors, determine the relationship independence and outnerdependence criteria. After the normalization criteria and the latter multiplying matrix between the normalized weights with weight normalization. According balanced scorecard, the criteria used in this study can see at Figure 4.3.

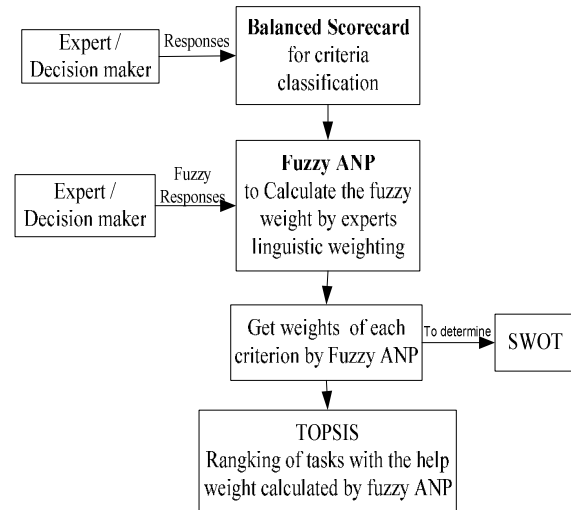


Figure 4.1. Schematic Diagram Of The Proposed Model For Determining Measuring Performance Of Small Medium Enterprise (SME)

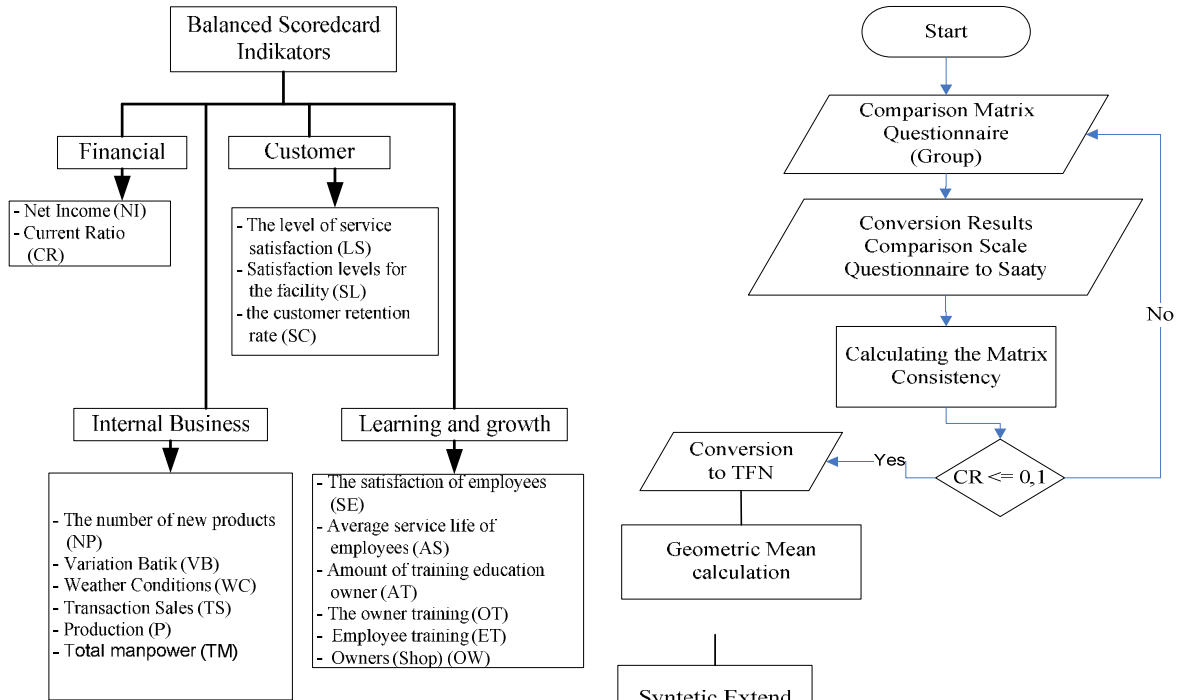


Figure 4.3. Balanced Scorecard Criteria's

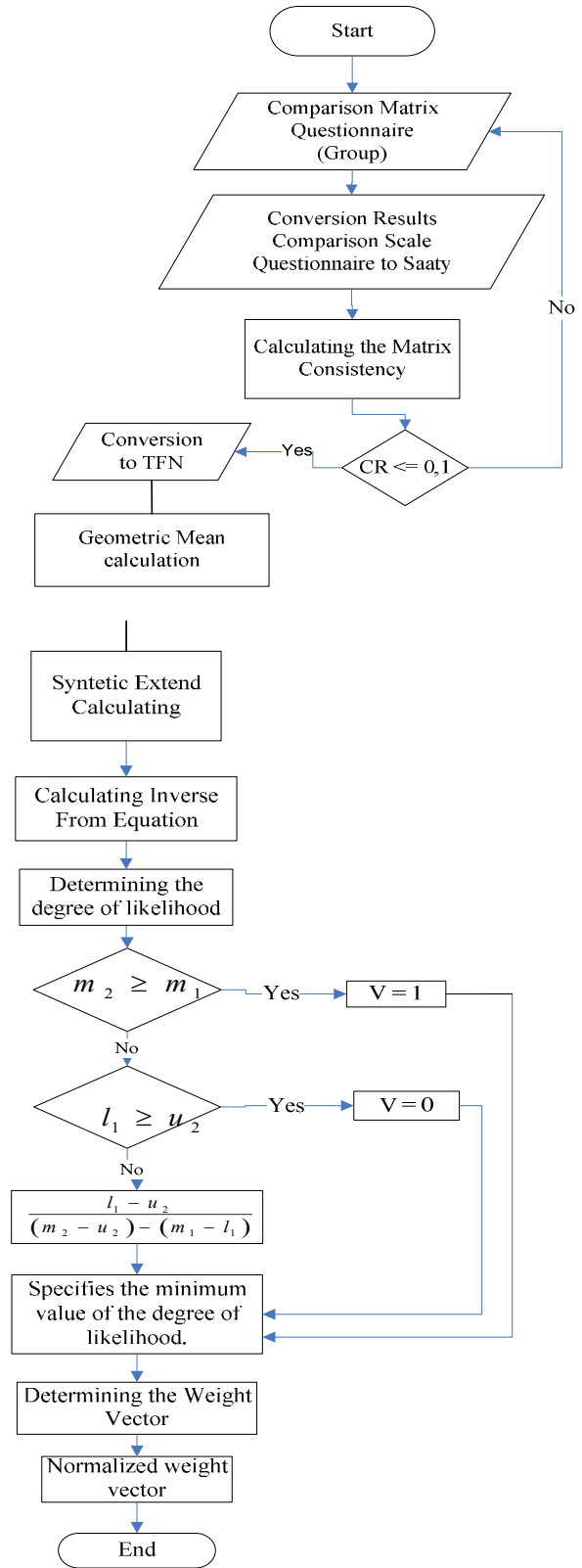


Figure 4.2. Flowchart Fuzzy ANP

4.1. Calculating Weight and Ranking

Weights obtained from the calculation method FANP. The initial step is to determine the weighting of each criterion alternatives through questionnaires owner.

- a. Pairwise Comparison specify criteria as shown in Table 4.1.

Table 4.1. Pairwise Comparison

Kriteria	LS	SL	CR	NP	SE	VB	WC	TS	P	TM
LS	1	5	5	5	3	3	3	3	3	3
SL		1	5	3	5	3	3	7	7	5
CR			1	3	5	5	5	3	7	7
NP				1	5	5	5	5	3	5
SE					1	3	5	5	5	5
VB						1	3	9	3	5
WC							1	5	3	3
TS								1	3	3
P									1	3
TM										1

- b. Determining Triangular Fuzzy Number to obtain the value of Lower, Middle, Upper
- c. Determining the value of Synthetic Extend
- d. Determining Weight Vectors
- e. Determining the normalization Weight Vector such as in the table below

Table 4.4. Weight Vector

LS	SL	CR	NP	SE	VB	W C	TS	P
0,08	0,09	0,08	0,082	0,0742	0,073	0,07	0,068	0,06
T M	SC	AS	AT	OT	ET	O W	NI	Tot al
0,06	0,05	0,05	0,034	0,029	0,03	0,08	0,006	1

According to the Table 4.4. Shown that the weight of the criteria in each perspective that most influence on SMEs in Bangkalan Indonesian is Satisfaction level for facility (SL), New Product (NP), Level of Service (LS), Current Ratio (CR) and Owner (OW).

- f. Results Conversion Value Criteria on SMEs

Table 4.5. Results Conversion Value Quantitative Criteria On Smes

Weight	SME 1	SME 2	SME 3	SME 4	SME 5
0,081	2	1	2	2	3
0,0864	3	4	4	4	3
0,0808	4	4	5	4	3
0,0818	1	1	3	4	3
0,0741	2	2	2	2	4
0,0734	3	2	3	3	5

0,0658	4	4	5	4	3
0,06753	5	2	2	5	3
0,05602	5	3	3	5	4
0,05639	5	3	4	4	3
0,0498	4	4	3	4	4
0,04713	4	4	3	3	4
0,0343	4	4	4	3	4
0,0291	4	4	4	2	4
0,033	3	3	2	3	3

Table 4.6. Multiplication Of Criteria Weight With Conversion Between Smes Ratings

SME 1	SME2	SME3	SME 4	SME5
0,162	0,081	0,162	0,162	0,243
0,2592	0,3456	0,3456	0,3456	0,2592
0,3232	0,3232	0,404	0,3232	0,2424
0,0818	0,0818	0,2454	0,3272	0,2454
0,1482	0,1482	0,1482	0,1482	0,2964
0,2202	0,1468	0,2202	0,2202	0,367
0,2632	0,2632	0,329	0,2632	0,1974
0,33765	0,1351	0,1351	0,3377	0,2026
0,2801	0,1681	0,1681	0,2801	0,2241
0,28195	0,1692	0,2256	0,2256	0,1692
0,1992	0,1992	0,1494	0,1992	0,1992
0,18852	0,1885	0,1414	0,1414	0,1885
0,1372	0,1372	0,1372	0,1029	0,1372
0,1164	0,1164	0,1164	0,0582	0,1164
0,099	0,099	0,066	0,099	0,099
0,3835	0,1534	0,3068	0,3068	0,3835
0,0186	0,0186	0,0186	0,0186	0,0186

According to the table 4.6. It can be seen each weight indicator of SMEs, so that from this table can be in the know SWOT recommendations for improvement and determination of the SMEs. In Figure 4.4. Shown a graph comparing the performance of each criteria of the SME.

- g. Ranking SME, according to TOPSIS method with distance Positive ideal solution and negative ideal solution on table 4.7.

Table 4.7. Calculation With TOPSIS Method

SME Name	Positive ideal solution	Negative ideal solution	Ideal Solution
SME 1	23,892	79,559	0,769
SME 2	76,838	41,441	0,350
SME 3	53,365	55,857	0,511
SME 4	48,158	60,592	0,557
SME 5	34,754	74,256	0,681

Based on table 4.7. That the sequence of SMEs with the best performance are as follows SME 1, SME 5, SME 4, SME 3, SME 2 .

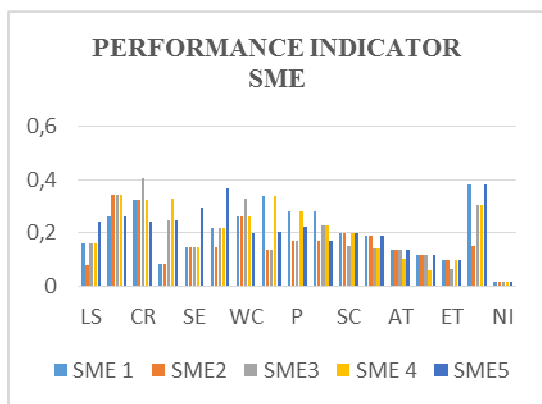


Figure 4.4. Performance Comparison Chart Of Each Criterion Of Smes

5. CONCLUSIONS

1. Based on this research can be concluded that the recommendation SME performance can be determined based on the weighted method FANP. Using fuzzy ANP in determining criteria weight of each indicator can be determined by the level of interest. This method determines the weighting of criteria based on the level of importance of the SME department so that all SME in Indonesian mapped based on the performance of each indicator.
2. According test results with the scale of assessment of the SME different interests and also the relationship between the different criteria that performance appraisal obtained on the scale of high importance and there are many linkages between criteria. The factors affect performance SME in Indonesia are Satisfaction level for the facility (SL), New Product (NP), Level of Service (LS), Current Ratio (CR) and Owner (OW).

3. Limitation of this research is that the criteria used in this study in accordance with the conditions and standards Bangkalan SMEs in Indonesia, so there are some criteria that are not appropriate if it is implemented elsewhere. There are several criteria that difficult to measure and thus require a specific method and this research could be developed with other methods of weighting and ranking the process, such as fuzzy interval AHP or the other.

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