

# Implementation of Matlab to Determine the Most Favorite Logistics Shipping Using Fuzzy Analytical Network Process and Fuzzy Vikor Methods

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**ABSTRACT :** *This thesis discusses the decision-making system for the selection of the most favorite logistics shipping in one of the e-commerce sites, namely Tokopedia. The decision-making system in this study uses 2 methods, fuzzy ANP and fuzzy VIKOR. Fuzzy ANP in this study is used to determine the weight of each criterion for the selection of logistics shipping, the criteria used are price, service and responsiveness. Fuzzy VIKOR is used for the ranking of alternative shipping expedition options. One of the famous e-commerce stores in Indonesia is Tokopedia. The alternative used in this study is in accordance with the choice logistics shipping on e-commerce Tokopedia, there are JNE, TIKI, Pos Indonesia, Wahana, Sicepat, and J&T Express. Data collection in this study was carried out using a questionnaire with respondents, the respondents are students of the UniversitasBrawijaya Mathematics Undergraduate Study Program class of 2020/2021. The results of this study are the contribution values obtained using MATLAB software on each of the criteria for price, service, and responsiveness are services 55.84%, responsiveness 34.46%, and price 9.7%. Furthermore, alternative ranking of the most favorite logistics shipping services on Tokopedia e-commerce for undergraduate study program students batch 2020/2021 UniversitasBrawijaya using fuzzy ANP and fuzzy VIKOR methods is J&T Express.*

**KEYWORDS** *Decision Making System, Fuzzy ANP, Fuzzy VIKOR, Logistics Shipping*

Date of Submission: 23-11-2022

Date of acceptance: 07-12-2022

## I. INTRODUCTION

Online business is a business that is marketed through the internet in various ways so that it can make money. In online business, there are many advantages compared to offline business. Online shopping or shopping via the internet, is a process of purchasing goods or services from those who sell via the internet, or buying and selling services online without having to meet face-to-face with the seller or the buyer directly[1]. So, online shopping is the process of buying and selling, and or services without meeting sellers and buyers directly. One of the most famous e-commerce online shops in Indonesia is Tokopedia. Tokopedia leads the online shopping market in Indonesia, based on SimilarWeb data for the Indonesian marketplace category ([www.cnnindonesia.com](http://www.cnnindonesia.com)). From this data, during the January 2021, the nation's children's platform led the way with a traffic share of 32.04 percent, with 129.1 million visits.

With so many choices of shipping expeditions, customers are faced with several choices of expedition services to send goods that have been purchased on Tokopedia e-commerce. Expeditions for delivery of goods contained in Tokopedia definitely have advantages and disadvantages of each in shipping goods. Customers should be able to choose an expedition according to their criteria of needs

In this study, two Multi-Criteria Decisions Making (MCDM) methods will be used, there are Fuzzy ANP and Fuzzy VIKOR to select or determine the favorite shipping expedition on Tokopedia e-commerce and will be processed using MATLAB software. Fuzzy ANP is used to determine the weight of each criterion, while Fuzzy VIKOR is used to determine the ranking of the alternative shipping expeditions on Tokopedia e-commerce.

**II. DECISION SUPPORT SYSTEM (DSS)**

Decision support system (DSS) is a system that is able to provide problem solving skills and communication skills for problems with semi-structured and unstructured conditions. This system is used to assist decision making in semi-structured and unstructured situations.[2].

The decision-making process consists of the following steps:

- Formulate the need for decision making
- Analysis and formulation of alternatives to deal with problems
- Considering and selecting alternatives
- Communication and implementation of decisions
- Follow-up and feedback

**III. FUZZY ANALYTICAL NETWORK PROCESS (FANP)**

FANP is a combination of fuzzy and ANP methods. The Fuzzy Analytic Network Process (FANP) covers the weaknesses found in the Analytic Network Process (ANP), there are problems with criteria that have more subjective characteristics. Fuzzy set theory helps in measurements related to human subjective judgments using language or linguistics [3].

In the FANP method, the first step is to form a pairwise comparison scale. In terms of the use of judgments, the data on the relative importance of the criteria is done by converting individual comparison decisions into a ratio of measurement scale using a scale of 1-9 or in other words, linguistic data is converted into a numerical scale by following the provisions in Table 2.1[4].

Table 3.1 Changes in Linguistic Scale to Numerical Scale

Numeric Scale	Linguistic Scale
1	equally influential
3	a little bigger effect
5	more influential
7	Very Bigger Influence
9	Absolute Greater Influence
2, 4, 6, 8	If in doubt on 2 scales, then take the middle score

Furthermore, the assessment on the pairwise comparison scale needs to be changed to the TFN value in the form (L,M,U) as presented in Table 2.3. FANP uses fuzzy ratios to replace the exact ratios of ANP in determining the preferences of decision makers.

Table 3.2. Triangular Fuzzy Scale Membership Function Terms

Numeric Scale	Membership Function(L, M, U)
x	$(\frac{x+1}{4}, \frac{x+3}{4}, \frac{x+5}{4})$

The consistent opinions are then combined using the geometric mean. The geometric mean is the square root of the product of the data.[5]

$$\bar{y}_g = \sqrt[n]{\prod_{i=1}^n x_i} = \left( \prod_{i=1}^n x_i \right)^{\frac{1}{n}}$$

with:

$\bar{y}_g$  =geometric mean

$x_i$ = i-th data

$n$  = lots of data

After getting the results of the mean geometry matrix, then the fuzzy synthesis value is calculated. The fuzzy synthetic value is used to obtain the expansion of an object using the following equation:

$$S = \sum_{j=1}^m M_{gi}^j \otimes \left[ \sum_{i=1}^n \sum_{j=1}^m M_{gi}^j \right]^{-1}$$

fuzzy synthesis values for each of these criteria will be used to find the degree of possibility. To get the probability degree of  $M_i(l_i, m_i, u_i) \geq M_j(l_j, m_j, u_j)$  used [5]:

$$V(M_i \geq M_j) = SUP_{x \geq y} [\min(\mu_{M_j}(x), \mu_{M_i}(y))]$$

where:

$V(M_i \geq M_j)$  = probability degree of  $K_i(l_i, m_i, u_i) \geq K_j(l_j, m_j, u_j)$

SUP = supremum (the upper limit of the smallest set)

$\mu_{M_j}(x)$  = membership function  $M_j(x)$

$\mu_{M_i}(y)$  = membership function  $M_i(y)$

if there is a couple set  $(x, y)$ , where  $x \geq y$  and  $\mu_{M_j}(x) = \mu_{M_i}(y)$ , so :

$$V(M_i \geq M_j) = \mu_{Ka}(d) \begin{cases} 1, & \text{if } m_i \geq m_j \\ 0, & \text{if } l_j \geq u_i \\ \frac{l_j - u_i}{(m_i - u_i) - (m_j - l_j)}, & \text{to others} \end{cases}$$

where  $d$  is the ordinate of the highest intersection point D between  $\mu_{M_j}$  and  $\mu_{M_i}$ . Therefore, we make comparison between  $M_i$  and  $M_j$  so that  $V(M_i \geq M_j)$ .

#### IV. FUZZYVIKOR

VIKOR (*Vise Kriterijumska Optimizacija I Kompromisno Resenje*) is a multi-criteria optimization method used in complex systems. This method focuses on ranking to select a set of alternatives, and determining a compromise solution to the problem of conflicting criteria. In the fuzzy ANP calculation, the weight of the criteria for the next stage is obtained using the VIKOR fuzzy calculation. The first step in fuzzy VIKOR is to change the results that have been filled in by respondents regarding alternative evaluations by paying attention to each criterion into the form of TFN and pairwise comparison matrices.

$$\tilde{D} = \begin{bmatrix} \tilde{r}_{11} & \tilde{r}_{12} & \dots & \tilde{r}_{1n} \\ \tilde{r}_{21} & \tilde{r}_{22} & \dots & \tilde{r}_{2n} \\ \dots & \dots & \dots & \dots \\ \tilde{r}_{n1} & \tilde{r}_{n2} & \dots & \tilde{r}_{nm} \end{bmatrix}$$

Where,  $\tilde{r}_{ij} = (a_{ij}, b_{ij}, c_{ij})$ ,  $\forall i, j$  is Triangular Fuzzy Number (TFN). Determine FBV and FWV, FBV is the largest value of each criterion and FWV is the smallest value of each criterion.

$$\tilde{f}_j^* = \max_i \tilde{r}_{ij}, \forall j$$

$$\tilde{f}_j^- = \min_i \tilde{r}_{ij}, \forall j$$

Matrix normalization is done using the following formula.

$$\tilde{R}_{ij} = \left( \frac{\tilde{f}_j^* - \tilde{r}_{ij}}{\tilde{f}_j^* - \tilde{f}_j^-} \right)$$

where,

$\tilde{R}_{ij}$  = Result of normalization of alternative i on criterion j

$\tilde{f}_j^*$  = Maximum value in one criterion j

$\tilde{f}_j^-$  = Minimum score in one criterion j

$\tilde{r}_{ij}$  = The value of alternative i and criterion j

Determine  $\tilde{S}_i$  (*maximum group utility*) and  $\tilde{R}_i$  (*Individual regret of the opponent*) both state utility measures that will measure from the farthest point and the closest point of the ideal solution, with the following formula [6]

$$\tilde{S}_i = \sum_{j=1}^n \tilde{W}_j \left( \frac{\tilde{f}_j^* - \tilde{r}_{ij}}{\tilde{f}_j^* - \tilde{f}_j^-} \right)$$

$$\tilde{R}_i = \text{Max } j \left[ \tilde{W}_j \left( \frac{\tilde{f}_j^* - \tilde{r}_{ij}}{\tilde{f}_j^* - \tilde{f}_j^-} \right) \right]$$

with  $\tilde{W}_j$  is the weight given to each criterion j. After calculating the value of  $\tilde{S}_i$  and  $\tilde{R}_i$  determine  $\tilde{S}_i^*$ ,  $\tilde{S}_i^-$  and  $\tilde{R}_i^*$ ,  $\tilde{R}_i^-$ . determine  $\tilde{Q}_i$  on each alternative i, using the formula

$$\tilde{Q}_i = v \left[ \frac{\tilde{S}_i - \tilde{S}_i^*}{\tilde{S}_i^- - \tilde{S}_i^*} \right] + (1 - v) \left[ \frac{\tilde{R}_i - \tilde{R}_i^*}{\tilde{R}_i^- - \tilde{R}_i^*} \right]$$

where  $v$  is the maximum weight of the utility group, while  $1 - v$  is weight of individual regret. The value of  $v$  is assumed to be 0.5 [7].

### V. MATRIX LABORATORY (MATLAB)

MATLAB is a computer program (software) that can help solve mathematical problems found in life, more precisely in the technical field. MATLAB's ability to find solutions to various numerical problems quickly and precisely, from the most basic, such as a system of two equations with two variables to complex ones, such as finding the roots of polynomials, interpolation of a data, calculations with matrices, signal processing, and numerical methods [8].

In MATLAB there are many toolboxes that are used to solve problems and make it possible to learn and apply certain technologies. Various toolboxes in Matlab include signal processing, control systems, neural networks, fuzzy logic, wavelets, simulation, statistics, optimization, bioinformatics, genetic algorithms and others. MATLAB is widely used in mathematics and computing, development and algorithms, programming modeling, simulation and prototyping, analysis and statistics, and engineering application development [9].

### VI. METHODS AND MATERIALS

Types and sources of data are divided into two, there are primary data and secondary data. Primary data is data obtained from the first source either from individuals, the results of this primary data in the form of interviews or the results of filling out questionnaires that are usually carried out by researchers. In this study, the primary data used was the result of filling out the questionnaire. The questionnaire was filled out by respondents, the respondents in this study were students of the 2020/2021 academic year of the undergraduate mathematics study program Brawijaya University and the samples used in this study were respondents or students who had bought goods on e-commerce Tokopedia. The steps of this research are as follows.

1. Problem identification and data retrieval.
2. Data processing using Fuzzy ANP (Weighting on Criteria) with MATLAB
3. Data processing using Fuzzy VIKOR with MATLAB
4. Weighted matrix normalization
5. Calculate the value of  $S_i$
6. Calculate the value of  $Q_i$
7. Defuzzifikasi
8. Alternative Ranking.

### VII. RESULT AND DISCUSSION

Based on the calculation of the value of fuzzy synthesis and the value of the weight of the criteria using MATLAB can be seen in Figure 7.1. Calculation of the value of the fuzzy weight synthesis on each criterion in MATLAB needs to input the criteria paired comparison matrix.

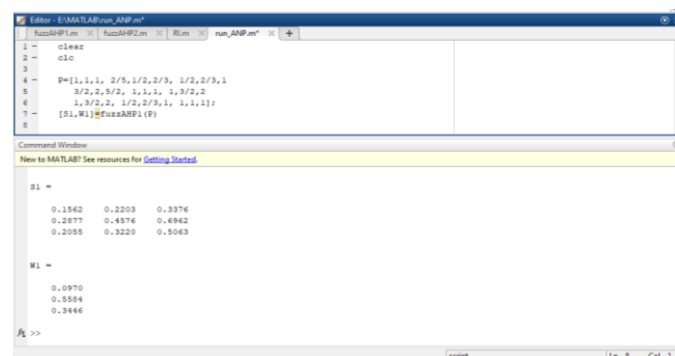


Figure 7.1 Calculation of fuzzy synthesis and criterion weights with MATLAB

The weight calculation is the result of the normalized vector weight, from the normalized vector weight the normal weight vector value is obtained which states the contribution or weight value for each price, service, and responsiveness criteria of delivery services, are service of 55.84%, responsiveness 34.46%, and price 9.7%.

The same calculation steps are carried out to calculate alternative weights on service criteria and alternative weights on responsiveness criteria using MATLAB, by inputting a pairwise comparison matrix in the form of TFN for alternatives on service and responsiveness criteria. Calculations using MATLAB for alternative weights on each criterion can be summarized in Table 7.2

Table 7.2 Alternative weights on criteria

	Price	Service	Responsiveness
A1	0,1989	0,2179	0,1926
A2	0,0368	0,0235	0,0114
A3	0,0391	0,1873	0,1262
A4	0,0365	0,0261	0,0322
A5	0,2681	0,2285	0,3116
A6	0,4206	0,3167	0,326
MAX	0,4206	0,3167	0,326
MIN	0,0365	0,0235	0,0114

Then calculate the normalization of the matrix, calculate the value of  $\tilde{S}_i$ , and calculate the value of  $\tilde{R}_i$ , with the weights on each criterion contained in Table 7.2. After getting the  $\tilde{S}_i$  and  $\tilde{R}_i$  values, it will be calculated for the  $\tilde{Q}_i$  value. Ranking using the VIKOR fuzzy method by sorting the  $\tilde{Q}_i$  values from the smallest to the largest value. based on the  $\tilde{Q}_i$  calculation, the ranking of the most favorite logistics shipping can be seen in Table 7.3

Table 7.3 Alternative ranking

No.	Alternative	$Q_i$
1	A6 J&T	0
2	A5 Si Cepat	0,2233
3	A1 JNE	0,2964
4	A3 Pos Indonesia	0,7207
5	A4 Wahana	0,8142
6	A2 TIKI	0,8277

Based on Table 5.16 the smallest  $\tilde{Q}_i$  value is alternative A6, there is J&T Express freight forwarding services with a zero  $\tilde{Q}_i$  value. These results are in accordance with the calculation of alternative weights on each criterion, where alternative A6 always has the greatest weight than other alternatives. Alternative A6 has a weighted value of 0.4206 on price criteria, 0.3167 on service criteria, and 0.3260 on responsiveness criteria. While the largest  $\tilde{Q}_i$  value is alternative A2, there is TIKI delivery services with a  $\tilde{Q}_i$  value of 0.8277. Alternative A2 has the smallest weight value on the service criteria, there is 0.0235 and on the responsiveness criteria, there is 0.0114.

## VIII.CONCLUSION

Based on the objectives and research results that have been obtained, it can be determined, the weight of the criteria for shipping goods on Tokopedia e-commerce can be determined using fuzzy ANP. Determination of the weight of the criteria is done by linguistic weighting by the respondents, and calculated using the fuzzy ANP method with MATLAB. The weight of the criteria for the favorite shipping expedition on Tokopedia e-commerce using fuzzy ANP are the weight of the service criteria is 55.84%, the responsiveness is 34.46%, and the price is 9.7%. The most favorite shipping expedition on Tokopedia e-commerce for students of the undergraduate mathematics study program batch 2020/2021 Universitas Brawijaya can be determined using fuzzy ANP and fuzzy VIKOR. The result of this calculation is that the most favorite shipping expedition on Tokopedia e-commerce for students of the undergraduate mathematics study program batch 2020/2021 Brawijaya University is J&T Express.

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