Implementation Of Vikor Algorithm In Web-Based Recommendation System For Obstetrician Selection

Richard Andrew[1], Fenina Adline Twince Tobing[2*], Adhi Kusnadi[3]

[1,2,3] Program studi Informatika, Fakultas Teknik dan Informatika,
Universitas Multimedia Nusantara, Jakarta, Indonesia
[*]Corresponding Author:
Email: fenina.tobing@umn.ac.id

Abstract.
The process of childbirth is a natural event for women; with the increase in birth rates, selecting a suitable obstetrician becomes essential. However, many couples find it challenging to choose the right obstetrician, from consultations to hospital births. This study aims to develop an obstetrician recommendation system to overcome decision-making challenges that involve many criteria. The method used is VIseKriterijumska Optimizacija Kompromisno Resenje (VIKOR), which is one of the best methods in Multiple Criteria Decision Making (MCDM) for ranking and selecting alternatives. This method involves several steps, including determining the weight of the criteria, normalizing the matrix, calculating the Utility Measure and Regret Measure, and calculating the VIKOR index. Testing was carried out through scenario tests and user survey tests using the USE questionnaire. The scenario test results show the successful implementation of VIKOR in this system. The results of the user survey test indicated a high level of satisfaction with a score of 83.34%, which fulfilled the four variables in the USE questionnaire: usability (79.76%), ease of use (84.81%), ease of learning (84.81), and satisfaction (83.31%). The results of this study have important implications for increasing the effectiveness of decision-making in selecting the right obstetrician. By incorporating the VIKOR method into an application, this research provides a valuable contribution to developing a VIKOR-based recommendation system. It emphasizes the importance of applying this method in complex decision-making environments.

Keywords: *Childbirth, Multiple Criteria Decision Making (MCDM), Obstetrician, Recommendation System, VIseKriterijumska Optimizacija Kompromisno Resenje (VIKOR).*

I. INTRODUCTION

The process of childbirth is a normal event that is important in a woman's life. The term "normal" describes that labour and birth have occurred for many years[1]. The population growth in the world is increasing due to the increasing number of births that occur[2]. In general, the birth process is carried out in a maternity hospital with the help of an obstetrician[3]. Selection of the right obstetrician according to individual needs is an essential factor. However, many parents-to-be couples face difficulties choosing the right obstetrician to help, from health consultations for pregnant women to assisting in the hospital's delivery process. This uncertainty in choosing an obstetrician significantly impacts the experience and outcome of labour[4]. Therefore, an approach is needed to help prospective parents make wise decisions. One proposed solution is developing a web-based recommendation system to help users consult[5].A recommendation system is a method developed to predict an item and display the best item value for the user. This system can filter relevant information and provide obstetrician recommendations that best suit the preferences and criteria of each pair of prospective parents. This system aims to assist users in navigating the various choices of obstetricians efficiently, considering the role of obstetricians is crucial in the delivery process. Using a recommendation system can reduce the burden of information users receive and guide them in making better decisions[6]. This system will create a model based on user input regarding the user's references[7].

The model developed will be used by the system so that it will filter information and adjust it to the criteria entered by the user so that it displays the recommendations that the user wants.Previous research created a decision support system for selecting obstetricians using the Technique for Order of Preference by Similarity to the Ideal Solution (TOPSIS) method[8].In this study, calculations were carried out using five criteria or attributes to determine which obstetrician the pregnant woman would choose. The criteria used are delivery rates, consultation rates, hospital position, obstetrician popularity and experience. The research was conducted on five users with different weight values for each user. The results obtained from the recommendation system using TOPSIS[9] were a 40% difference between the system results and the actual data results, so the recommendation system had significant and inaccurate error accuracy. Research conducted by Lahby et al.[10] compared several Multi Attributive Decision Making (MADM) algorithms,

including TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) and VIKOR (VIseKriterijumska Optimizacija Kompromisno Resenje)[11].

The research aims to choose which algorithm is best for mobile network selection in heterogeneous wireless networks. The study conducted four simulations with four traffic types: background, conversational, interactive and streaming. The results show that the ranking of the VIKOR method in the four simulations is superior to the TOPSIS method, so it can be concluded that the VIKOR method provides better results than the TOPSIS method.Based on previous research, this research will create a recommendation system for obstetricians using the VIKOR method with the hypothesis that better results can be achieved. The VIKOR approach involves several stages, including determining criteria weights, matrix normalization, Utility Measure and Regret Measure calculations, and VIKOR index calculations[12]. This recommendation system will be tested through scenarios and user surveys using the USE questionnaire[13]. The scenario testing results will show the effectiveness of implementing the VIKOR method in this system. In contrast, the user survey results will provide insight into user satisfaction with the system being developed.This research has important implications for improving the quality of decision-making[6] in selecting obstetricians. By applying the VIKOR method in an application, this research can make a real contribution to developing a more sophisticated and efficient recommendation system. Thus, this research emphasizes the importance of applying reliable decision-making methods in complex scenarios.

II. METHODS

System and Database Design

The system design was created by creating a flowchart[14] using diagrams.net to describe the workflow of a web-based obstetrician recommendation application using the VIKOR method. The database used was also designed using phpMyAdmin[15] to create a MySQL database[15]. Database design involves a table structure that supports the storage of obstetrician criteria and information to be assessed.

Evaluation Criteria

This research considers five main criteria in selecting an obstetrician, namely:

1. Hospital Accreditation[16]: Accreditation of the hospital where the doctor practices
2. Insurance[17]: BPJS Health services provided by obstetricians
3. Obstetricians Experience: Obstetrician practice experience in the field of obstetrics
4. Consultation Rates[18]: Consultation rates charged by obstetricians
5. Childbirth Rates[19]: Childbirth rates charged by obstetricians

Data was obtained via the official website of the Hospital Accreditation Commission (http://www.kars.or.id/). In contrast, data on BPJS Health services, obstetrician practice experience, delivery rates and consultation rates were obtained manually from the Alodokter website (https://www.alodokter.com/) and the SehatQ website (https://www.sehatq.com/). There are 15 lines of criteria data taken from these sources.

Application Workflow

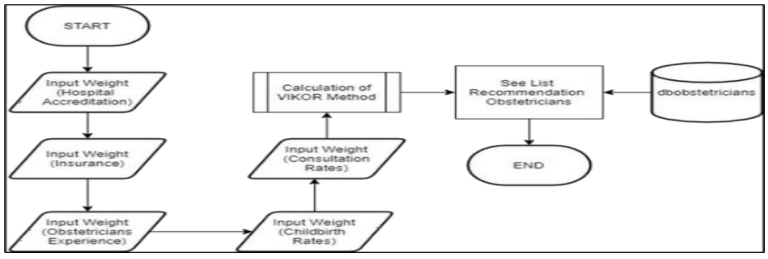

Fig 1. Web Application Flowchart

Figure 1 is a flowchart or workflow of the running process of a web-based obstetrician recommendation system application using the VIKOR method. Users who use this application will be asked to enter five criteria, namely:

1. Input hospital accreditation
2. Input BPJS (Insurance) services

3. Input the obstetrician's experience
4. Input consultation rates
5. Input childbirth rates

After inputting the data, calculations are carried out using the VIKOR method according to the previous formula. After the calculation is complete, the obstetrician's ranking will be displayed according to the criteria entered by the user.

VIKOR Method

According to El-Santawy[20], the VIKOR method (VIseKriterijumska Optimizacija Kompromisno Resenje in Serbian, which means Multicriteria Optimization and Compromise Solution) is a method introduced as a technique that can be applied in MCDM. This method focuses on ranking and selecting existing alternatives based on conflicting criteria. According to Zimmerman[21], MCDM consists of two models, namely Multi-Objective Decision Making (MODM) and Multi-Attribute Decision Making (MADM). The difference between the two models is that MADM is used to solve problems in continuous space, while MADM is used to solve problems in discrete areas. The VIKOR method is included in MADM because it solves problems related to assessing or selecting several alternatives using predetermined criteria[22].

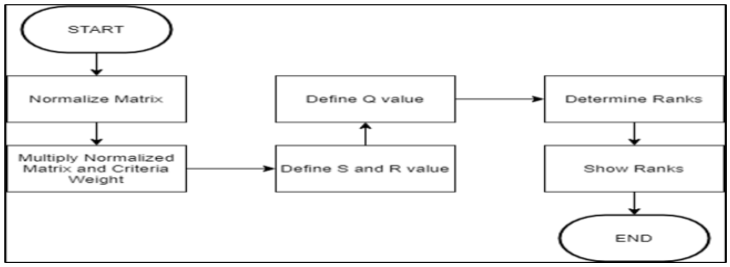

Fig 2. Flowchart of the VIKOR Method

Figure 2 is a flowchart of the VIKOR method in general, with the procedure[23] explained below:

1. Normalize the decision matrix used in the VIKOR method calculations with the following formula:

$$R_{ij} = \frac{(f_i^* - f_{ij})}{f_i^* - f_i^-} \quad (1)$$

Rij = normalization value of sample i criterion j
fij = sample data value i criterion j
$fi*$ = the best value in one criterion
$fi-$ = worst value in one criterion

2. Calculate the normalized matrix with weights for each criterion that has been determined using the following formula

$$F^*_{ij} = w_j * N_{ij} \quad (2)$$

$F*ij$ = normalized data value that has been weighted for alternative i on criterion j
wj = weight value on criterion j
Nij = normalized data value for alternative i on criterion j
i = 1,2,3, ..., m are alternative sequence numbers
j = 1,2,3, ..., n is the attribute or criteria sequence number

3. Calculate the values of Si (the maximum group utility) and Ri (the minimum individual regret of the opponent), i = 1, 2, …, m, with the following relationship

$$S_i = L_{1,i} = \sum_{j=1}^{n} w_j \left(x^*_j - x_{ij}\right)/(x^*_j + x^-_j) \quad (3)$$

$$R_i = L_{\infty,i} = \max_j[\sum_{j=1}^{n} w_j \left(x^*_j - x_{ij}\right)/(x^*_j + x^-_j)] \quad (4)$$

4. Calculate the values of Qi, i = 1, 2, … , m, with the following relationship

$$Q_i = v(S_i - S^*)/(S^- - S^*) + (1-v)(R_i - R^*)/(R^- - R^*) \quad (5)$$

$S*$ = min i Si, $S-$ = max i Si, $R*$ = min i Ri, $R-$ = max i Ri and v is the weight of strategy Si and Ri

After the collection of Q values is obtained, the ranking will be carried out by sorting the best data, which has the lowest Q value, to the worst data, which has the largest Q value.

Testing and Analysis

Testing is done by testing the recommendation system through scenarios and user surveys. The results of scenario testing will measure the effectiveness of implementing the VIKOR method in this system. Meanwhile, the user survey results will provide insight into the level of user satisfaction with the system developed using the USE Questionnaire.The USE Questionnaire is a method used to measure the usability of a recommendation system. USE Questionnaire is a package comprising four research variables: usefulness, ease of use, ease of learning and satisfaction[24]. Each variable has questions that will be used to evaluate a recommendation system. Testing the recommendation system with the USE Questionnaire is expected to provide information and empirical evidence about the usability of using the recommendation system, which can illustrate whether the system is following user needs or not so that it can provide convenience and satisfaction to users.Respondents were asked to provide answers based on a Likert scale with five alternative answers. The scores obtained from these questions will then be calculated using a specific formula and converted into predetermined eligibility categories. The following criteria for using the Likert scale can be seen in Table 1.

Table 1. Criteria for Using the Likert Scale

Score	Answer Criteria
1	Strongly Disagree (SD)
2	Disagree (D)
3	Neutral (N)
4	Agree (A)
5	Strongly Agree (SA)

After getting the value for each question, usability measurement is carried out by calculating the answers from respondents using the following formula.

$$Eligible\ Percentage = \frac{Observed\ Score}{Expected\ Score} \times 100 \quad (6)$$

The results of the eligibility percentage for each variable are then converted using the feasibility category table in Table 2.

Table 2. Eligibility Category

Number (%)	Classification
< 21	Very Inappropriate
21 – 40	Not Eligible
41 – 60	Enough
61 – 80	Decent
81 – 100	Very Decent

Analysis of the test results will provide information about the extent to which this recommendation system has succeeded in meeting user needs in selecting the appropriate obstetrician.

III. RESULT AND DISCUSSION

System Implementation

At this stage, the system is implemented using the Grocery CRUD administrator website, designed based on the PHP CodeIgniter framework[25]. To access this system, the user must log in first; then, the user will be directed to the main page of the administrator's website, as shown in Figure 3.

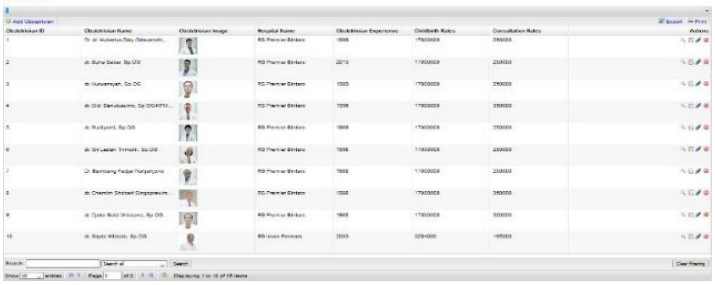

Fig 3. Main page of the Administrator Website

The main page immediately displays a list of obstetricians who are the objects of research.

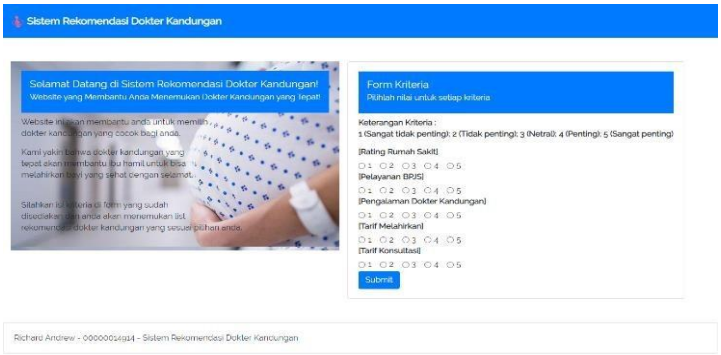

Fig 4. Main page of the Recommendation System

Figure 4 shows the main page of the obstetrician recommendation system using the VIKOR method. Website users will receive information about the recommendation system website and the form that must be filled in to get the obstetrician's recommendation results. No recommendation results will appear if the user does not fill out the form completely.

Fig 5. Results of Obstetrician Recommendations

Figure 5 is an image that displays the results of the recommendations after the user fills out the criteria form completely. The recommendation results are displayed in a table and contain the obstetrician's photo, the obstetrician's ID, the obstetrician's name, the hospital where the obstetrician practices, hospital address, hospital contact, consultation fees, maternity fees and the obstetrician's practice experience.

Recommendation System Scenario Test

The scenario trial of the obstetrician recommendation system using the VIKOR method was carried out using obstetrician data, as shown in Table 3.

Table 3. Obstetrician Data

ID	Hospital Rating	BPJS	Experience	Childbirth Rates	Consultation Rates
1	5	1	21	17000000	250000
2	5	1	7	17000000	250000
3	5	1	31	17000000	250000
4	5	1	24	17000000	350000
5	5	1	31	17000000	250000
6	5	1	22	17000000	250000
7	5	1	32	17000000	250000
8	5	1	32	17000000	350000
9	5	1	32	17000000	350000
10	4	1	17	3294000	165000
11	3	0	5	5500000	175000
12	3	0	4	6492870	225000
13	3	0	15	6492870	225000
14	1	0	12	5992490	140000
15	1	0	15	5992490	140000

After obtaining obstetrician data that will be used in VIKOR calculations, the criteria weight data obtained from the user will be compiled along with the maximum value, which is the best value for each criterion and the minimum value, which is the worst value for each measure, which is displayed in Table 4.

Table 4. Criteria Weights and Maximum and Minimum Values

Criteria	Weight	Total Weight	Max	Min
Hospital Rating	2	0.15384615384615	5	1
BPJS	3	0.23076923076923	1	0
Experience	4	0.30769230769231	32	4
Child Rates	1	0.076923076923077	3294000	17000000
Consultation Rates	3	0.23076923076923	140000	350000

After that, matrix normalization was carried out according to the obstetrician's data in Table 3 and the maximum and minimum values contained in Table 4 using formula (1). After normalization is carried out, the normalized data will be multiplied by the weight value for each criterion with formula (2). After obtaining the results of multiplying the normalization matrix with the criteria weights, the next step is to find the S-value (utility measures) using formula (3) and the R-value (regret measures) using formula (4). After obtaining the S and R values from each obstetrician's data, the next step is to find the maximum and minimum values of the S and R values. The S and R values from each obstetrician's data, as well as the maximum and minimum values of S and R, will be used to find the Q value or VIKOR index with formula (5) and the value v = 0.5 After obtaining the Q value for each data, we will immediately rank it by sorting the Q values from the smallest Q value to the largest Q value shown in Table 5.

Table 5. Vikor Ranking

ID	Q Grade
7	0
3	0.010387723
5	0.010387723
6	0.103877231
1	0.114264954
10	0.148810228
8	0.397994878
9	0.397994878
4	0.481096663
15	0.661616456
2	0.671457783
13	0.679852693
14	0.692779626
11	0.902994451
12	1

The VIKOR ranking results in Table 5 will be converted into a table in the obstetrician recommendation system web application shown in Figure 6.

Fig 6. Recommendation Results in Web Applications

The figure shows that the data from manual calculations and the data from measures in the system show the same results.

System User Survey Test

A system user survey test was conducted to determine the responses of several respondents who used this application. The questionnaire used for user survey testing is the USE questionnaire. After the questionnaire results are obtained, a calculation is carried out to determine the value of the distributed USE questionnaire. Value calculations are carried out for each variable in the USE questionnaire: the variable's usefulness, ease of use, ease of learning and satisfaction. According to formula (6).

Table 6. USE questionnaire calculation results

Variable	Results
Usefulness	79.76 %
Ease of use	84.81 %
Ease of learning	85.48 %
Satisfaction	83.32 %
Average	**83.34 %**

Table 6 is the result of calculating the USE questionnaire for each variable and the average for the entire questionnaire. After calculating each variable, a percentage value was obtained for each variable, namely the usefulness variable with a percentage of 79.76%, the ease of use variable with a rate of 84.81%, the ease of learning variable with a rate of 85.48%, and the satisfaction variable with a rate of 83.31%. Measuring the overall USE questionnaire value produces a feasibility percentage value of 83.34%, which shows that the results of testing the obstetrician recommendation system using the VIKOR method have a value that is "very feasible" according to the feasibility category in Table (2).

IV. CONCLUSION

In this research, a web-based obstetrician recommendation system was successfully implemented using the VIKOR method using the PHP programming language. This system can provide obstetrician recommendations according to the criteria determined by the user with the weight of each measure, which can be adjusted according to preferences.In this research, scenario testing and user surveys were carried out. The results of scenario trials on this system show the effectiveness of implementing the VIKOR method. The obstetrician data that has been entered, the matrix normalization process, and the calculation of the VIKOR index value consistently produce recommendations that match user preferences. This provides an overview of the system's ability to process and analyze data accurately to provide meaningful recommendations.In-user survey testing is carried out using the USE questionnaire.

This testing gave us insight into user responses and satisfaction with this system. The average result of user survey testing is 83.34%, which means it shows an excellent level of feasibility with four variables: usefulness, ease of use, ease of learning and satisfaction, all of which meet the requirements and obtain positive responses from users.Overall, this research has proven that a web-based obstetrician recommendation system using the VIKOR method has the potential to provide an effective solution in selecting an obstetrician. Nonetheless, this research has the potential for further development by improving more comprehensive data integration and current updates regarding obstetricians and hospitals. Developing additional features, such as user reviews and the possibility of selecting by location, could also improve the system's usability.

V. ACKNOWLEDGMENTS

Thank you to Multimedia Nusantara University for providing funding support and providing research space.

REFERENCES

[1] Kassa ZY, Tsegaye B, Abeje A, *Disrespect and abuse of women during the process of childbirth at health facilities in sub-Saharan Africa: a systematic review and meta-analysis,*. ***BMC Int Health Hum Rights***.

[2] Krishnapriya KS, Albiero V, Vangara K, King MC, Bowyer KW, *Issues Related to Face Recognition Accuracy Varying Based on Race and Skin Tone,*. ***IEEE Transactions on Technology and Society***. 2020;1(1):8-20.

[3] Siregar R, Zarlis M, Situmorang Z, *Tsukamoto's Fuzzy Logic Development Analysis to Predict Caesarean or Normal Delivery,*. In: *2020 3rd International Conference on Mechanical, Electronics, Computer, and Industrial Technology (MECnIT)*. IEEE; 2020:152-157. doi:10.1109/MECnIT48290.2020.9166594.

[4] Onchonga D, Várnagy Á, Keraka M, Wainaina P, *Midwife-led integrated pre-birth training and its impact on the fear of childbirth. A qualitative interview study,*. ***Sexual & Reproductive Healthcare***.

[5] De Proost L, Geurtzen R, Ismaili M'hamdi H, Reiss IKM (Irwin), Steegers EAP (Eric), (Joanne) Verweij EJ, *Prenatal counseling for extreme prematurity at the limit of viability: A scoping review,*. ***Patient Educ Couns***. 2022;105(7):1743-1760. doi:10.1016/j.pec.2021.10.033

[6] Tobing FAT, Dzulhaq MI, Overbeek MV, Setiawan EA, *Design of Decision Support System with C4.5 Algorithm Methods in Determining Results Vaname Shrimp Cultivation*,. In: *2019 5th International Conference on New Media Studies (CONMEDIA)*. IEEE; 2019:195-200. doi:10.1109/CONMEDIA46929.2019.8981848.

[7] Valentine L, D'Alfonso S, Lederman R, *Recommender systems for mental health apps: advantages and ethical challenges*,. ***AI Soc***. 2023;38(4):1627-1638. doi:10.1007/s00146-021-01322-w.

[8] Ortíz-Barrios M, Gutiérrez-Severiche E, Cómbita-Niño D, et al., *A multicriteria decision-making framework for assessing the performance of gynecobstetrics departments: a case study*,. ***International Transactions in Operational Research***. 2023;30(1):328-368. doi:10.1111/itor.12946.

[9] Kusnadi A, Kurniawan E, *Implementation of Topsis Method In Web Based System Recommendations For Students Laptop Selection (Case Study: Bhinneka.com)*,. ***International Journal of New Media Technology***.

[10] Lahby M, Baghla S, Sekkaki A, *Survey and comparison of MADM methods for network selection access in heterogeneous networks*,. In: *2015 7th International Conference on New Technologies, Mobility and Security (NTMS)*. IEEE; 2015:1-6. doi:10.1109/NTMS.2015.7266522

[11] Zhu GN, Ma J, Hu J, *A fuzzy rough number extended AHP and VIKOR for failure mode and effects analysis under uncertainty*,. ***Advanced Engineering Informatics***. 2022;51:101454. doi:10.1016/j.aei.2021.101454.

[12] Bera B, Shit PK, Sengupta N, Saha S, Bhattacharjee S, *Susceptibility of deforestation hotspots in Terai-Dooars belt of Himalayan Foothills: A comparative analysis of VIKOR and TOPSIS models*,. ***Journal of King Saud University - Computer and Information Sciences***. 2022;34(10):8794-8806. doi:10.1016/j.jksuci.2021.10.005

[13] Cameron EE, Joyce KM, Delaquis CP, Reynolds K, Protudjer JLP, Roos LE, *Maternal psychological distress & mental health service use during the COVID-19 pandemic*,. ***J Affect Disord***. 2020;276:765-774.

[14] Rahayu, S., Zufrizal, Z., Astuty, W., & Triastuti, H. (2020). Keputusan Hedging dan Faktor-Faktor yang Mempengaruhinya pada Perusahaan Pertambangan yang Terdaftar di Indeks Saham Syariah Indonesia (ISSI). Institut Penelitian dan ***Kritikus Internasional Budapest-Jurnal (BIRCI-Journal)*** , 3 (4), 2662-2676.

[15] Shreya JL, Saini A, Kumari S, Jain A, *Generic Recommendation System for Business Process Modeling*,. In: ; 2023:267-282. doi:10.1007/978-981-99-3010-4_24.

[16] Sriratana W, Khagwian V, Satthamsakul S, *Analysis of Electric Current by Using MySQL Database on Web Server for Machine Performance Evaluation: A Case Study of Air Conditioning System*,. In: *2020 20th International Conference on Control, Automation and Systems (ICCAS)*. IEEE; 2020:437-442.

[17] Avia I, Hariyati RrTS, *Impact of hospital accreditation on quality of care: A literature review*,. ***Enferm Clin***. 2019;29:315-320. doi:10.1016/j.enfcli.2019.06.003

[18] Sarkum, S., Syamsuri, A. R., & Supriadi, S. (2020). The role of multi-actor engagement. ***Journal of Open Innovation: Technology, Market, and Complexity***, 6(4), 176.

[19] Laagu MA, Setyo Arifin A, *Analysis the Issue of Increasing National Health Insurance (BPJS Kesehatan) Rates through Community Perspectives on Social Media: A Case Study of Drone Emprit*,. In: *2020 International Conference on Smart Technology and Applications (ICoSTA)*. IEEE; 2020:1-7.

[20] Li Y, Yan X, Song X, *Provision of Paid Web-Based Medical Consultation in China: Cross-Sectional Analysis of Data From a Medical Consultation Website*,. ***J Med Internet Res***. 2019;21(6):e12126. doi:10.2196/12126.

[21] Temkina A, *'Childbirth is not a car rental': mothers and obstetricians negotiating consumer service in Russian commercial maternity care*,. ***Crit Public Health***. 2020;30(5):521-532. doi:10.1080/09581596.2019.1626004

[22] El-Santawy MF, *A VIKOR Method for Solving Personnel Training Selection Problem*,. In: ; 2012.

[23] Lubis, H., & Pratama, K., Safrida, S. (2022). HR related antecedes to sustainability reporting in Indonesian public listed firm: The mediating role of employee committeemen. *Cuadernos de Economía, 45*(128), 87-97.

[24] Zimmermann HJ, *Fuzzy Set Theory—and Its Applications*. Springer Netherlands; 2001.

[25] Supriadi, ., Dalimunthe, R. F., Lumbanraja, P., & Tarmizi, H. B. (2021). The Antecedent Of Educational Staff Contextual Performance In Medan City Private Universities. Archives of Business Research, 9(2), 316–338.

[26] Ishak A, Asfriyati, Nainggolan B, *RETRACTED: Integration of Fuzzy AHP-VIKOR Methods in Multi Criteria Decision Making: Literature Review*,. ***IOP Conf Ser Mater Sci Eng***. 2020;1003(1):012160.

[27] Rani P, Mishra AR, Mardani A, Cavallaro F, Štreimikienė D, Khan SAR, *Pythagorean Fuzzy SWARA–VIKOR Framework for Performance Evaluation of Solar Panel Selection*,. ***Sustainability***. 2020;12(10):4278.

[28] Alturki U,Aldraiweesh A, *Application of Learning Management System (LMS) during the COVID-19 Pandemic: A Sustainable Acceptance Model of the Expansion Technology Approach*,. ***Sustainability***. 2021;13(19):10991.

[29] Belgacem K, Kenoui M, Bouguerra F, Laidi M, Semrani A, Sellah C, *Collaborative Visualization and Annotations of DICOM Images for Real-Time Web-based Telemedicine System*,. In: *2021 International Conference on Recent Advances in Mathematics and Informatics (ICRAMI)*. IEEE; 2021:1-6.