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MULTI-OBJECTIVE METHOD COMBINATION ANALYSIS OPTIMIZATION ON THE BASIS ON RATION ANALYSIS (MOORA) AND BEST FIRST SEARCH ALGORITHM IN THE SELECTION OF OBSTETRICIAN AND GYNECOLOGY PRACTICES

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ABSTRACT

The health of pregnant women must be given great attention to assist in the delivery process and prevent maternal death. Based on the results of data from the Ministry of Health, currently, the maternal mortality rate in Indonesia is relatively high, as much as 32% of maternal deaths in Indonesia occur due to bleeding and another 26% occur due to hypertension which can cause seizures and poisoning. Routine check-ups with an obstetrician are one of the right steps to maintain the health of mothers and children during pregnancy. Therefore, this study tries to develop an application that can help pregnant women to find recommendations for obstetricians and gynecologists. By using the Multi-Objective Optimization based on Ratio Analysis (MOORA) method is to find out where obstetricians and gynecologists practice recommendations and the Best First Search (BFS) method is used to determine the optimal sequence of selecting practices based on the results of the MOORA method. This study is on patient satisfaction, service quality, accessibility, and cost efficiency. Based on the results of the user acceptance test, the results show that this system can meet demand and can be used properly.

Keywords: *Multi-Objective Optimization Based On Ratio Analysis (MOORA), Best First Search Algorithm, Obstetrics And Gynecology Practices, Practice Selection.*

1. INTRODUCTION

The health of pregnant women must be given great attention for early detection of child illnesses assisting the birthing process and preventing maternal death [1]. Currently, the maternal mortality rate in Indonesia is still relatively high. As many as 32% of maternal deaths in Indonesia occur due to bleeding, and 26% of others occur due to hypertension which can cause seizures, as well as poisoning [2]. Regular check-ups with a doctor or obstetrician are the right step to maintain maternal health and children during pregnancy.

Obstetricians are doctors who study the system of female reproduction. A gynecologist holds the SpOG title which is an acronym for Specialist in Obstetrics & Gynecology (Obstetrics and Gynecology). The duties and responsibilities of a SpOG are not just to do a pregnancy check and help with the birthing process. However, a SpOG also treats various other disease conditions related to the female reproductive system. Refers to [3], a person with a SpOG degree can provide internal services planning a pregnancy, diagnosing precancerous conditions, and looking for or providing solutions regarding sexual dysfunction in women, complete problems with pregnancy, menstruation, fertility, and menopause. So this proves that it is very important to see a doctor SpOG.

Getting the best service is certainly a patient priority. Getting the best service requires a SpOG doctor who has the best qualifications. Current conditions for selecting SpOG doctors. This is done by surveys or listening to testimonials from other patients. To simplify and streamline the search and selection of SpOG doctors [4]. A decision support system is needed that can provide SpOG doctor recommendations that meet the patient's criteria. In

the previous research, five criteria were used to build a support system for the decision to select an obstetrician, namely delivery rates, rates consultation, position, popularity, and experience [5]. In this research, the literature sample used to justify the problem research is adequate because it requires a decision-support system in providing doctor recommendations that meet the patient's criteria, and in this study, five criteria were also used to build a decision-support system for selecting an obstetrician, namely consultation rates, delivery rates, facilities, service, and location.

In developing a decision support system, of course, a method or algorithm is needed that helps the calculation process and provides recommendations. In this research, the method will be used multi-Objective Optimization based on Ration Analysis (MOORA). This method gives good results in helping users make decisions, this is based on research results [6]. In this research, the MOORA method was used for selecting suppliers of manufacturing materials. MOORA has also been used [7] in assessing the feasibility of giving business capital loans at the Bank. It was concluded that this method provides a precise and accurate assessment so that it can used as a basis for making more rational decisions. If compared to other methods such as the TOPSIS method, the MOORA method is superior where the accuracy of the system using MOORA is 91.78% while TOPSIS was 80.14% [8]

To make it easier for users, the system built in this research will also be able to provide recommendations for the shortest route by implementing the Best First Search (BFS) algorithm. This method is a heuristic search method, as the name suggests then the search will be carried out by going directly to the node with best value/cost. As research results [9], the BFS method makes it easier to find the shortest route to find a partner. This is also in line with research results [10] that this method will provide a route during traffic jams.

The research aims to help convey the results of recommendations for consideration so that they can be implemented in the decision support system for selecting obstetrics and gynecology practice doctors in the city of Medan appropriately.

So based on the explanation above, this will be done implementation and combination of MOORA and BFS methods. MOORA will be used to provide practice location recommendations for obstetricians and gynecologists based on five criteria and BFS will used to provide recommendations for the shortest route from a location system users go to the location of the doctor's practice.

1.2. Formulation of the Problem

How to build a decision support system that can provide recommendations for places to practice for obstetricians and gynecologists in Medan City using the MOORA method and provide recommendations for the shortest route to the location of their practice by implementing the BFS algorithm.

2. LITERATURE REVIEW

2.1 Decision Support System

A Decision Support System (DSS) can be defined as a process of selecting existing alternatives based on existing criteria to achieve or obtain the alternative that best suits the selected criteria [11]. The development of a DSS needs to be carried out if the system being built is considered to be able to increase productivity and performance in decision-making. In essence, DSS is carried out through a systematic approach through a data collection process which is then followed by a process of converting the data into information and processing it into factors that can influence the decision-making process.

2.2. MOORA Method

The Multi-Objective method based on ratio analysis (MOORA) is a method that was first introduced by Brauers and Zavadkas in 2006 [12]. MOORA can be interpreted as a method that has minimum calculations and calculations and can be classified as simple. The MOORA method uses an approach where two processes are carried out simultaneously to optimize two or more conflicting attributes [13]. This method is considered to have a level of flexibility and is easy to understand in the process of separating objects to the process of evaluating decision weight criteria.

The process for completing decision-making using MOORA is as follows:

1. Create a decision matrix
   In this process, the criteria values will be converted into a decision matrix. The conversion process is formed into a matrix as follows:

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1j} \\ x_{21} & x_{22} & \cdots & x_{2j} \\ \vdots & \vdots & \vdots & \vdots \\ x_{i1} & x_{i2} & \ldots & x_{ij} \end{bmatrix}$$

   Information:
   X: Decision matrix

i: Index alternative
j: Index of attribute or criterion
x_{ij}: Response alternative i to criterion j

Normalization of the decision matrix:

The purpose of normalization using the MOORA method is to equalize all matrix element values. The formula used to normalize the decision matrix is as follows:

$$x_{ij}^{*} = \frac{x_{ij}}{\sqrt{\left[\sum_{i=1}^{m} x_{ij}^{2}\right]}}$$

Information:
x_{ij}: Matrix alternative i to criterion j
i: Index alternative
j: index criterion or attribute
x_{ij}^{*}: Matrix normalization alternative j to criterion

2. Optimizing Attributes

In this process, the optimization value of attribute multiplication from the decision matrix is calculated. Optimization is carried out with the following equation:

$$y_i = \sum_{i=1}^{g} w_i x_{ij}^{*} - \sum_{i=g+1}^{n} w_i x_{ij}^{*}$$

Information:
i: Attributes or criteria with maximized status
$j = g + 1$: Attributes or criteria with minimized status
w_i: Weight alternative i
y_i: Normalized assessment value of alternative i for all attributes

3. Ranking

The ranking is done by sorting the y_i values. So the y_i value shows the best alternative value.

2.2 Graph Theory

A graph can be interpreted as a set of vertices and edges which is denoted as G = (V, E) where vertices are points and are not an empty set while edges are connecting lines between 2 points [14].

2.3 Best First Search Algorithm

Best First Search (BFS) is a combination of the Breadth First Search (BFS) algorithm and the Depth First Search (DFS) algorithm. The performance of this algorithm is essentially carried out by selecting nodes that are more suitable to be generated or presented as a solution. The selection is based on the evaluation function f (n). This function can be defined as the estimated cost from a point to the destination point or this function can also be a combination of estimated costs and actual costs.

According to [15] the following are the steps of the Best First Search (BFS) algorithm:

1. Place the starting point in the OPEN queue.
2. Then do the following steps until the destination is found or until the OPEN queue is empty:
   a. Take the best node from OPEN
   b. Resurrect all the successors
   c. For each successor, do:
      - If the point has never been generated, evaluate the point and put it in OPEN
      - If the point has already been generated, change the parent if the new trajectory is better or more promising. Then delete the point from OPEN.

3. RESULT AND DISCUSSIONS

3.1 System Implementation

1) Introduction Page

The introduction page is the first time this page appears when the system is run. This page provides introductory information in the form of an app logo, app title, image, and a button to go to the dashboard page. The appearance of the introduction page is shown in Figure 1.

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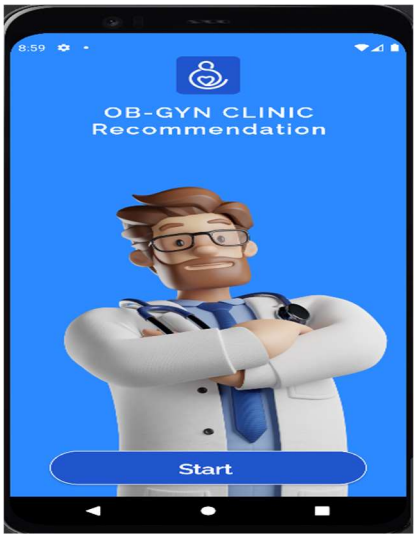

Figure 1: Introduction Page

2) Dashboard Page

The Dashboard page presents several appropriate input criteria user needs at the clinic or hospital that will be sought by the system and a search button to provide appropriate recommendations for user requirements that have been entered previously. The appearance of the dashboard page is shown in Figure 2.

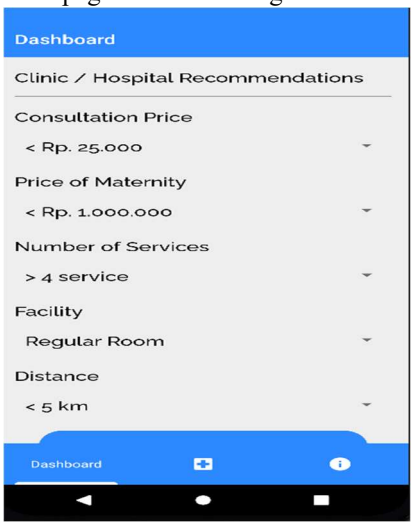

Figure 2: Dashboard Page

3) Clinic/Hospital Recommendations Page

The clinic/hospital recommendation page will display recommendations for alternative/hospital clinics according to the needs of existing users entered previously. Users can view clinic information or hospitals by clicking on one of the clinics/hospitals. The display of clinic/hospital recommendations is shown in Figure 3.

Figure 3: Clinic/Hospital Recommendations Display

4) Clinic/Hospital Page

The clinic/hospital page presents all clinic or hospital data that has been provided, can also display complete information by clicking on one of the clinics/hospitals can also display the route from the user location to the clinic/hospital by clicking a button route on the clinic/hospital information. The clinic page view/hospital is shown in Figure 4.

Figure 4: Clinic/Hospital Page

5) Clinic/Hospital Details Page

The Clinic/Hospital Details page provides complete information on one of the clinics or

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hospitals after one of the data is clicked on by users in the clinic/hospital list. On this page, there is a route button to go to the map page where this page can display the route from the user's location to the clinic/hospital location that has been selected by the user. The clinic/home detail page displays pain shown in Figure 5.

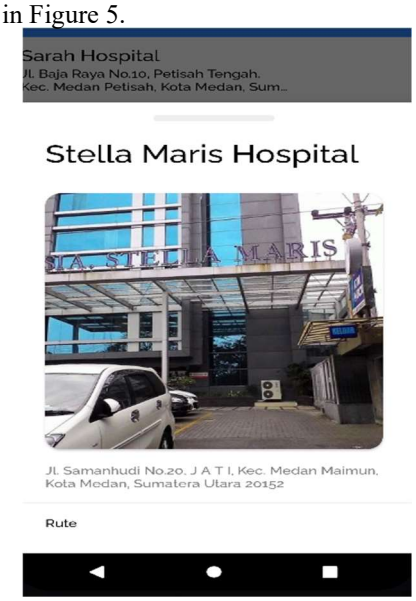

Figure 5: Clinic/Hospital Details Page

6) Map Page

The Map page is this page showing the route from the location of users to the location of the clinic/hospital via the map. And system creates a route line from the user's location to the clinic/hospital location with the help of the Google Maps API. The map page display is shown below in Figure 6.

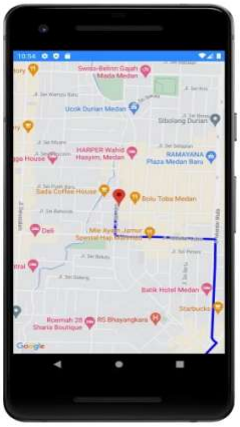

Figure 6: Map Page

7) About Page

The About page provides information about how to use the application. The appearance of the About page is shown in Figure 7.

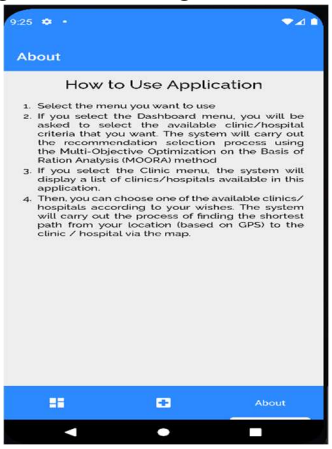

Figure 7: About Page

3.2 Testing

System testing is a stage carried out to prove that the system that has been built can run and be used appropriately design that was created in the previous stage.

1) Testing the Implementation of the MOORA Algorithm

This test will be carried out by inputting 5 criteria, namely: price consultation worth < Rp. 25,000, the delivery price is < Rp. 1,000,000, number of services of > 4 services, facilities worth a Regular Room, and distance is < 5 km. The following clinic/hospital data has been provided and listed in Table 1.

Journal of Theoretical and Applied Information Technology
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Table 1: Clinic/Hospital Data Table

Code	Name of clinic / Hospital	Consultation rates	Delivery rates	Service	Facility	Distance
C01	Sarah Hospital	2	1	2	2	5
C02	Stella Maris Hospital	2	1	2	1	5
C03	Mitra Medika Hospital	2	1	2	2	5
C04	Private Practice Midwife Hj. Nilawaty	5	5	2	3	4
C05	Pimgadi Hospital	5	4	2	2	4
C06	Columbia Asia Hospital	1	1	1	1	5
C07	Dena Ria Clinic	5	5	2	3	2
C08	Royal Prima Hospital	3	3	1	2	5
C09	Rizki Clinic	5	5	1	3	4
C10	Sampali Clinic	5	4	1	3	4
C11	Sari Ratna Clinic	5	4	2	3	4
C12	Rosita Clinic	5	4	3	3	4
C13	Sally Clinic	5	4	1	3	4
C14	Delfri Clinic Midwife Lusiana Gultom	5	4	4	3	4
C15	Zuraida Specialist Clinic	4	5	2	3	4
C16	Sri Utami Pohan Midwife Clinic	5	4	1	3	4
C17	Anna Maternity Home	5	4	3	3	4
C18	Independent Midwife Practice Nova Evelina Siregar S.Keb	5	5	2	3	4
C19	Midwife Eka Sriwahyuni	5	5	3	3	4
C20	Pratama Mahdarina Clinic	5	5	4	3	4
User	User	5	5	4	3	5

Then, carry out calculations by normalizing the decision matrix. Normalization of the decision matrix is carried out with the following equation:

$$x_{ij}^{*} = \frac{x_{ij}}{\sqrt{\left[\sum_{i=1}^{m} x_{ij}^{2}\right]}}$$

Table 2: Decision Matrix

Code	w_1	w_2	w_3	w_4	w_5
C01	4	1	4	4	25
C02	4	1	4	1	25
C03	4	1	4	4	25
C04	25	25	4	9	16
C05	25	16	4	4	16
C06	1	1	1	1	25
C07	25	25	4	9	4
C08	9	9	1	4	25
C09	25	25	1	9	16
C10	25	16	1	9	16
C11	25	16	4	9	16
C12	25	16	9	9	16
C13	25	16	1	9	16
C14	25	16	16	9	16
C15	16	25	4	9	16
C16	25	16	1	9	16
C17	25	16	9	9	16
C18	25	25	4	9	16
C19	25	25	9	9	16
C20	25	25	16	9	16
User	25	25	16	9	25
$\sqrt{\sum_{i=1}^{n}(w_i)^2}$	20.3224	18.46619	10.81665	12.36932	19.44222

Table 3: Decision Matrix Normalization

Code	x_{i1}^{*}	x_{i2}^{*}	x_{i3}^{*}	x_{i4}^{*}	x_{i5}^{*}
C01	0.09841	0.05415	0.1849	0.16169	0.25717
C02	0.09841	0.05415	0.1849	0.08085	0.25717
C03	0.09841	0.05415	0.1849	0.16169	0.25717
C04	0.24603	0.27077	0.1849	0.24254	0.20574
C05	0.24603	0.21661	0.1849	0.16169	0.20574
C06	0.04921	0.05415	0.09245	0.08085	0.25717
C07	0.24603	0.27077	0.1849	0.24254	0.10287
C08	0.14762	0.16246	0.09245	0.16169	0.25717
C09	0.24603	0.27077	0.09245	0.24254	0.20574
C10	0.24603	0.21661	0.09245	0.24254	0.20574
C11	0.24603	0.21661	0.1849	0.24254	0.20574
C12	0.24603	0.21661	0.27735	0.24254	0.20574
C13	0.24603	0.21661	0.09245	0.24254	0.20574
C14	0.24603	0.21661	0.3698	0.24254	0.20574
C15	0.19683	0.27077	0.1849	0.24254	0.20574
C16	0.24603	0.21661	0.09245	0.24254	0.20574
C17	0.24603	0.21661	0.27735	0.24254	0.20574
C18	0.24603	0.27077	0.1849	0.24254	0.20574
C19	0.24603	0.27077	0.27735	0.24254	0.20574
C20	0.24603	0.27077	0.3698	0.24254	0.20574
User	0.24603	0.27077	0.3698	0.24254	0.25717

Then, the next step is to optimize the attributes viz calculation of the optimal value of attribute multiplication from the decision matrix is carried out. Optimization is carried out with the following equation:

$$y_i^{*} = \sum_{j=1}^{g} w_j x_{ij}^{*} - \sum_{j=g+1}^{n} w_j x_{ij}^{*}$$

Table 4: Attribute Optimization

Code	$w_1 \times x_{i1}^{*}$	$w_2 \times x_{i2}^{*}$	$w_3 \times x_{i3}^{*}$	$w_4 \times x_{i4}^{*}$	$w_5 \times x_{i5}^{*}$	y_i^{*}
C01	0.02952	0.01625	0.03698	0.01617	0.02572	**0.12464**
C02	0.02952	0.01625	0.03698	0.00808	0.02572	**0.11655**
C03	0.02952	0.01625	0.03698	0.01617	0.02572	**0.12464**
C04	0.07381	0.08123	0.03698	0.02425	0.02057	**0.23685**
C05	0.07381	0.06498	0.03698	0.01617	0.02057	**0.21252**
C06	0.01476	0.01625	0.01849	0.00808	0.02572	**0.0833**
C07	0.07381	0.08123	0.03698	0.02425	0.01029	**0.22656**
C08	0.04429	0.04874	0.01849	0.01617	0.02572	**0.1534**
C09	0.07381	0.08123	0.01849	0.02425	0.02057	**0.21836**
C10	0.07381	0.06498	0.01849	0.02425	0.02057	**0.20211**
C11	0.07381	0.06498	0.03698	0.02425	0.02057	**0.2206**
C12	0.07381	0.06498	0.05547	0.02425	0.02057	**0.23909**
C13	0.07381	0.06498	0.01849	0.02425	0.02057	**0.20211**
C14	0.07381	0.06498	0.07396	0.02425	0.02057	**0.25758**
C15	0.05905	0.08123	0.03698	0.02425	0.02057	**0.22209**
C16	0.07381	0.06498	0.01849	0.02425	0.02057	**0.20211**
C17	0.07381	0.06498	0.05547	0.02425	0.02057	**0.23909**
C18	0.07381	0.08123	0.03698	0.02425	0.02057	**0.23685**
C19	0.07381	0.08123	0.05547	0.02425	0.02057	**0.25534**
C20	0.07381	0.08123	0.07396	0.02425	0.02057	**0.27383**
User	0.07381	0.08123	0.07396	0.02425	0.02572	**0.27897**

After that, it will convert it into percentage units with the following equation:

$$\%y_i^{*} = \left|\frac{y_i^{*} - y_{user}}{y_{user}}\right| \times 100\%$$

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Table 5: Convert to Percentage

Code	y_i^*	%
C01	0.12464	44.67721
C02	0.11655	41.77923
C03	0.12464	44.67721
C04	0.23685	84.90039
C05	0.21252	76.17889
C06	0.0833	29.85968
C07	0.22656	81.21295
C08	0.1534	54.98792
C09	0.21836	78.27245
C10	0.20211	72.44893
C11	0.2206	79.07687
C12	0.23909	85.70481
C13	0.20211	72.44893
C14	0.25758	92.33275
C15	0.22209	79.60878
C16	0.20211	72.44893
C17	0.23909	85.70481
C18	0.23685	84.90039
C19	0.25534	91.52833
C20	0.27383	98.15628

Table 6: Ranking

Code	Name of Clinic / Hospital	$\%y_i^*$
C20	Pratama Mahdarina Clinic	98.15628
C14	Defri Clinic Midwife Lusiana Gultom	92.33275
C19	Midwife Eka Sriwahyuni	91.52833
C12	Rosita Clinic	85.70481
C17	Anna Maternity Home	85.70481
C04	Private Practice Midwife Hj. Nilawaty	84.90039
C18	Independent Midwife Practice Nova Evelina Siregar S.Keb	84.90039
C07	Dena Ria Clinic	81.21295
C15	Zuraida Specialist Clinic	79.60878
C11	Sari Ratna Clinic	79.07687
C09	Rizki Clinic	78.27245
C05	Pirngadi Hospital	76.17889
C10	Sampali Clinic	72.44893
C13	Sally Clinic	72.44893
C16	Sri Utami Pohan Midwife Clinic	72.44893
C08	Royal Prima Hospital	54.98792
C01	Sarah Hospital	44.67721
C03	Mitra Medika Hospital	44.67721
C02	Stella Maris Hospital	41.77923
C06	Columbia Asia Hospital	29.85968

3.3 Test Result

After the system testing process is carried out, it will be carried out comparison of test results with manual calculations. Testing this is done by inputting 5 criteria, namely: the consultation price is worth < Rp. 25,000, the delivery price is < Rp. 1,000,000, service amount of > 4 services, facilities worth a Regular Room, and distance worth < 5 km. Display of test results in clinic/hospital recommendations, shown in Figure 8, and Figure 9.

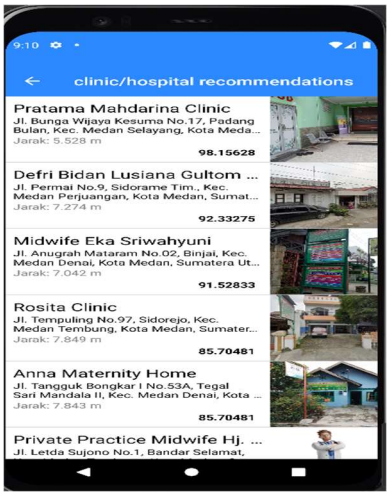

Figure 8: Results of Implementation of the MOORA Method (1)

Figure 9: Results of Implementation of the MOORA Method (2)

Based on Figure 6, Figure 7, Figure 8, and Figure 9 can be concluded that manual calculations are by results of recommendations on the application.

3.4 User Testing

User Acceptance Test (UAT) is a test carried out by users on the system that has been built. Following are the results from Users the Acceptance Test that has been carried out by the author is as follows.

Table 7: User Acceptance Test Table

Statement	Don't agree	Agree	Strongly agree
In terms of appearance, this application describes the system for selecting places to practice obstetrics and gynecology doctors in the city of Medan		√	
The menus available on the system are not difficult to use (user-friendly)			√
The system can help in obtaining information about choosing a place to practice for obstetricians and gynecologists		√	
The system can help make finding a doctor's practice for obstetrics and gynecology easier for users			√
This expert system is suitable for use by users			√

4. CONCLUSION

4.1 Conclusion

From the results of the study, it can be concluded that decision support systems can help deliver results recommendations for consideration so that they can be implemented field of decision support systems for physician practice selection obstetrics and gynecology in the city of Medan appropriately. Multi-objective optimization Method based on Ration Analysis (MOORA) and Best First Search (BFS) in selecting a doctor's practice obstetrics and gynecology in the city of Medan. Based on the results of the user acceptance test, the results obtained are that this system can meet requests and can be used well. The method to control applied so that the research findings are not influenced by unnecessary variations is the MOORA method, in this research MOORA is used to determine the obstetrician's recommendation that the patient needs after writing down the desired criteria.

4.2 Future Research

Based on the research that the researchers have done in this study, there are several suggestions for further development of this system, namely, the method used in the system for selecting obstetrician and gynecologist practices in the city of Medan should be developed together with other methods to increase the accuracy of the results obtained. Hospital/clinic data provided in the system should be added so that the recommendation results are more complete. The system is expected to be able to add chat features and make appointments with the doctor.

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