# Nutrition and Lifestyle Recommendations for Patients Recovering from Covid-19 in Nusa Tenggara Barat Province

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***Abstract* — Providing nutrition for COVID-19 patients is one of many actions to reduce the risk due to symptoms of COVID-19. To help meet the nutritional needs of COVID-19 cured patients, we developed a nutritional needs recommendation system and predicted nutritional needs for COVID-19 recovered patients in West Nusa Tenggara, Indonesia with Technique for the Order of Preference by Similarity to Ideal Solution method (TOPSIS). We use data from COVID-19 Task Force in this province along with The Indonesian Dietary Recommendations to help decide which nutrition is needed by recovered patients. The criteria used in the prototype of this system are Age Group weight 3, Vegetable Consumption weight 4, Fat Consumption weight 4, Salt & Sugar Consumption weight 2, and Sports weight 3. After cranking the two patterns used, the Pattern Preference value is obtained 1 = 0.34980639174099 and Pattern 2 = 0.65019360825901 so that the highest preference value that can be used as a recommendation is Pattern 2 with a preference value of 0.65019360825901.**

***Keywords—COVID-19, Nutrition Needs, TOPSIS, Decision Support System, Indonesia Dietary***

## I. INTRODUCTION

At present, the spread of diseases caused by the SARS-CoV-2 virus or known as COVID-19 still occurs in most countries in the world. There are 31,798,308 COVID-19 confirmed cases with 973,653 deaths (data at 24 September 2020 from https://covid19.who.int/). Meanwhile, in Indonesia, positive cases of COVID-19 reached 262,022 confirmed cases, with 10,105 deaths and 191,853 recovered patients (data on 24 September 2020 from https://covid19.go.id/).

Various methods are taken to treat COVID-19 patients, including intensive care, isolation for asymptomatic patients, administration of medicines to reduce the symptoms of COVID-19, and increasing endurance and nutrition for patients. Nutritional needs in patients help recover chronic and acute diseases and new unknown disorders [1]. Briguglio, Pregliasco, Lombardi, Perazzo and Banfi found an association between COVID-19 patients' symptoms and malnutrition symptoms in the patient's body [2]. COVID-19 can cause malnutrition, and the symptoms are reducing appetite, decreasing energy in the body, impaired absorption of nutrients in the body, and reducing body mass.

Calder, Carr, Gombart, Eggersdorfer describe nutrients such as vitamins (such as vitamins A, B6, B12, C, D, and E), minerals (such as zinc, iron, selenium, magnesium, and copper), and omega-three fatty acids play an essential role in supporting the immune system [3]. However, the nutrients most needed for COVID-19 patients to reduce malnutrition are energy, protein, fat, and carbohydrates [4]. Besides these nutrients, consuming high amounts of fiber, whole grains, and antioxidants also boosts immune function [5].

The provision of these nutrients must also adjust to the needs of the patients themselves, such as critical patients treated in the ICU [6], positive patients with no symptoms, and others. Patients who have recovered also need balanced nutrition to maintain endurance to reduce the risk of contracting it. The impact of nutritional needs in COVID-19 affects awareness and the interdependence of various levels to maintain endurance during the pandemic like an individual, local communities, government, and global community. [7]

In province West Nusa Tenggara province, Indonesia, there is sufficient spread in this Coronavirus, were 3,215 positive confirmed cases with 192 fatalities and 2538 recovered patients (data on 24 September 2020 from https://corona.ntbprov.go.id/). Although COVID-19 is still spreading rapidly, West Nusa Tenggara's food security during this pandemic is predicted high, based on average per capita expenditure for food needs [8]. Therefore, the potential for providing nutrition for its residents, both healthy and recently recovered from COVID-19, is increasing.

Providing the right nutrition and lifestyle according to the background and condition of each patient recovering from COVID-19 is considered very helpful in restoring the patient's immune system. Determining proper nutritional intake and lifestyle based on the patient's background and the condition tends to require an extended analysis, even less than optimal. If the decision making is done quickly and accurately, it will be carried out on many patients with different backgrounds and conditions. This condition is quite troublesome for the sick and health workers. Therefore, to overcome this problem, a decision-making system is needed to help health workers determine the nutrition and lifestyle of patients recovering from COVID-19 more quickly and precisely. One of the many decision-making systems applications is finding the ideal diagnostic model for COVID-19 [9].

Because of that potential, we will develop a decision-making system that will help medical authorities to make nutritional recommendations, and the lifestyle of COVID-19 recovered patients in the province of West Nusa Tenggara. We will apply the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) method for the decision-making process. This study's specific purpose was to find the best preference value of lifestyle and nutritional needs based on the criteria for Age Group, Vegetable Consumption, Fat Consumption, Salt & Sugar Consumption, and Exercise as recommendations for patients recovering from COVID-19. So that decision making by medical personnel, nutritionists, and the COVID-19 Task Force in NTB Province are more precise and accurate.

## II. Related Research

The literature that will be used as a reference in this research is research related to Multi-Criteria Decision Making in mitigating the handling conditions during the COVID-19 pandemic. One of the benefits of decision-making methods in handling the COVID-19 epidemic to determine the highest criteria in determining recommendations for preventive activities to reduce the risk of transmission of COVID-19 using AHP developed by Singh and Avikal [10]. The highest criteria and sub-criteria produced by this method are the Social Distancing Criteria and the Travel sub-criteria. These results suggest that reducing nonessential travel can reduce the spread of the virus.

Kumar, Khan, Gupta and Puppala used TOPSIS to determine the level of risk for COVID-19 [11]. The risk level's determination is based on predicting the COVID-19 case with three alternative prediction methods: Gaussian Process Regression, SVM, and Decision Tree. This study's results indicate that the model optimized with the Gaussian Process Regression has more accurate results with lower Root Mean Square Error-values than other methods.

The determination of risk factors for the spread of COVID-19 using TOPSIS was carried out by Majumder, Biswas and Majumder by changing the method of determining the ideal distance between alternatives with the Supremum metric method that resulted in a shorter distance compared to the Euclidean methods [12]. The data used are data on confirmed cases and deaths from 31 December 2019 to 5 April 2020. The sensitivity analysis of the TOPSIS model shows that contamination due to contact with an infected person is the highest risk factor for the spread of COVID-19.

Besides determining the level of risk for COVID-19, the combination of TOPSIS and AHP is used to determine the best date to enter campus amid the COVID-19 pandemic in China [13]. This date's determination is based on predicting the spread of COVID-19 in China using the SEIR-based method and the estimated number of residents who return flow after the Spring Break from Shanghai Hongqiao Station. The results of determining the best date to start an activity are 15-22 March 2020. Therefore, the best date to start campus activities is 23 March 2020.

Alqahtani and Rajkhan conducted a study to determine the highest critical success factor in using e-learning and models of using e-learning in Saudi Arabia during the COVID-19 pandemic, using AHP and TOPSIS methods, respectively [14]. The data used were taken from 69 people related to the management of E-learning. The search for critical success factors with AHP is that Knowledge Management, Support, Student Characteristics, and Information Technology factors are the key to success in the use of e-learning during a pandemic. Meanwhile, the most needed e-learning model in COVID-19 is blended learning.

Mohammed et al. use TOPSIS to assist health organizations in selecting a COVID-19 diagnosis system [9]. In this study, the recommendations are aimed explicitly at helping health organizations to diagnose COVID-19 patients. In our study, we provided nutritional recommendations for recovered patients using the TOPSIS method. The similarities to this paper are to provide recommendations to help health organizations and use the TOPSIS method.

Besides using paper containing COVID-19 related problem solving, we are also referring to some research about nutrition management in this pandemic. Thibault, Seguin, Tamion, Pichard and Singer explained nutrition management for COVID-19 patients in the intensive care unit (ICU) [6]. This study's results are that optimized nutrition care of the ICU COVID-19 patients is essential to maintain GI tract function, sustain immune defences, and avoid severe loss of muscle mass and function.

Chapple et al. show proper nutritional recommendations to prevent muscle deterioration and aiding recovery for COVID-19 patients who got ICU treatment in Australia and New Zealand [15]. This paper aims to provide medical therapy in intensive care and have potential nutrition implications for consideration. Optimal nutrition therapy, both in the ICU and after an ICU stay, should involve careful glycemic control management.

Fernández-Quintela et al. The purpose of this study is to look for the link between nutrition, the immune system COVID-19 [16]. It looks for patterns in patients' nutritional status due to COVID-19 infection and provides dietary recommendations for patients hospitalized. This paper's recommendations are reduced micronutrients because stress and infection can take supplements, but supplements can be consulted with a doctor.

Butler and Barrientos explain COVID-19 patients' impact if nutrition is not fulfilled, especially those who have congenital diseases [5]. This paper provides nutritional and dietary recommendations for patients who have recovered from COVID-19 but have congenital diseases. The results of this study state that healthy food must be a top priority and individuals must pay attention to healthy eating habits to reduce susceptibility and long-term complications from COVID-19.

The relationship between previous research and our research is using the Multi-Criteria Decision-Making method in handling related to the COVID-19 pandemic and providing the right nutritional solutions for COVID-19 patients. However, this study has differences in terms of methods, data used, the area studied, and recommendations. The first difference is that the method to be used is the decision-making method, namely TOPSIS. The second difference is the data used, namely data on patients who recovered from 5 April 2020 to 8 June 2020, from the COVID-19 Task Force in West Nusa Tenggara Province. The third difference is the recommendations in the form of food and drinks that should be consumed for recovered COVID-19 patients, according to predetermined age groups, and hospitals in West Nusa Tenggara to maintain their immunity.

## III. PROPOSED METHOD

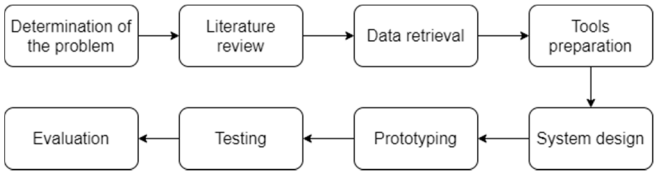



Fig. 1. Developing process flowchart

In this section, we explain the stages of the developing system and the system's decision-making process. The developing process is explained in Fig. 1.

### A. *Problem Determination and Literature Study*

Before we make the prototype, we will conduct a problem determination and literature study. Problem determination is for searching for other research that is related to the problem because of this pandemic. A literature study is an activity to obtain information about decision-making systems and nutritional needs based on balanced nutrition guidance.

### B. *Data Collection and Tool Preparation*

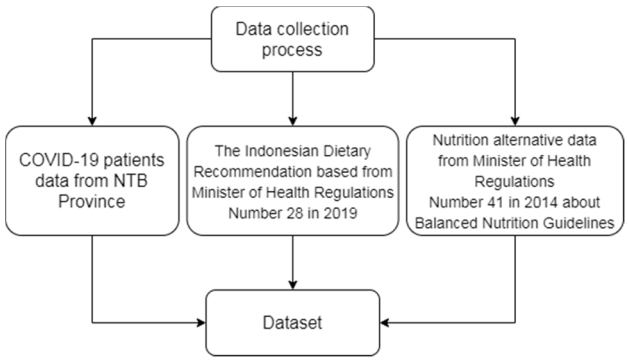



Fig. 2. Data Collection flowchart

After we do a literature study, we will collect data and prepare tools to make the prototype. Fig. 2. describes the flow of the data collection process. The data used for this study are patient data taken from the COVID-19 Task Force Handling website in NTB Province (URL address: https://corona.ntbprov.go.id/), the dietary recommendation (Minister of Health Regulation No.28 Year 2019), and alternative nutrition data (Minister of Health Regulation No.41 Year 2014). In tools preparation, we decided to use the XAMPP package, which consists of the PHP, MySQL for making a prototype.

### C. *System Design*

The prototype system design is done by designing data flow using Data Flow Diagrams (DFD) and designing database tables, as shown in Fig. 3. and Fig. 4. We make DFD diagrams up to 2 levels. The process contained in the DFD design are:

1) Input criterion data
2) Input criteria value data
3) Input alternative data
4) Input patient data
5) Input calculation data
6) Displaying results

After we design the Data Flow process, we create a database table that consists of tables related to the TOPSIS process. Tables of this database criteria, detailed criteria, alternatives, patient data, and TOPSIS tables to collect data from calculating criteria, weighting, and others.

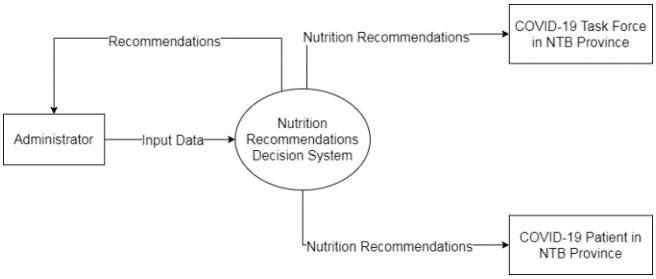



Fig. 3. Prototype's context diagram

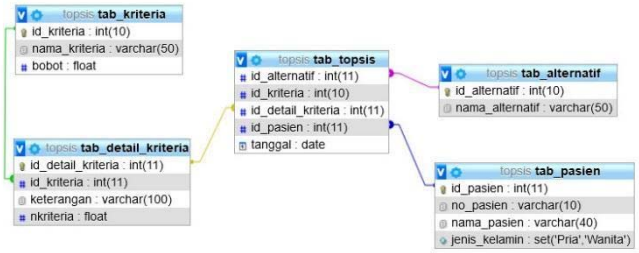



Fig. 4. Table relation design in the prototype's database

### D. *Prototyping*

This prototype will run with the TOPSIS method. TOPSIS itself is a method to find optimal alternatives with the shortest distance from the positive ideal solution (PIS) and have the farthest distance from the negative ideal solution (NIS) [17]. The algorithm consists of the steps:

1) Normalize the decision matrix;
2) Calculate the PIS and NIS;
3) Determine the distances between PIS and NIS;
4) Compute the relative nearest index of each alternative to the PIS;
5) Rank the alternatives from the most significant index of alternative. The bigger the index, the better the alternative.

In our prototype, the steps in generating recommendations are as follows:

1) Enter criteria data and its details;
2) Entering alternative data and patient data;
3) Calculate the criteria value and measures of weight;
4) Make a normalized matrix and a normalized matrix weighted;
5) Calculate positive and negative ideal solutions along with the distance from each solution;
6) Calculate the final score and rank recommendations based on the final score;
7) Showing the results of recommendations.

A further explanation of the generating recommendations algorithm can be seen in Fig. 5.

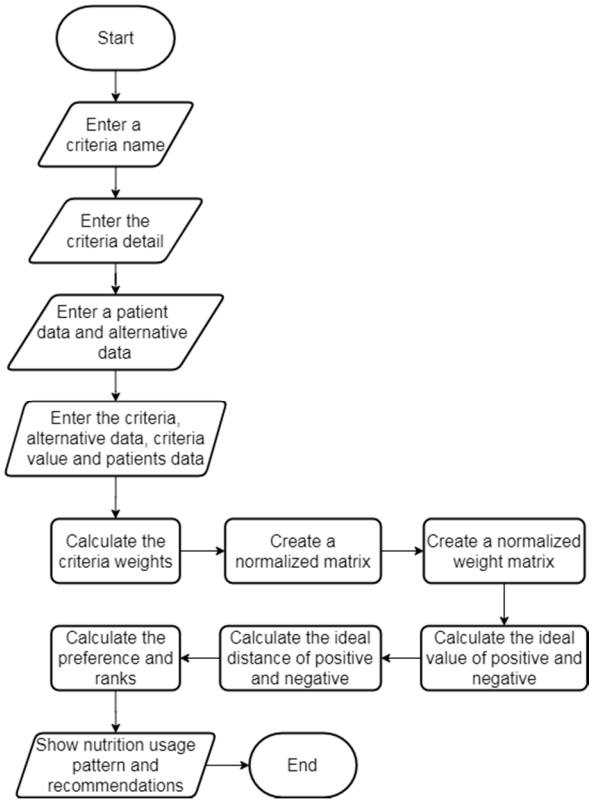



Fig. 5. Prototype's flowchart

## IV. Results And Discussions

In this section, we explain the results of the prototype and its testing results. The testing procedure contains two tests, namely functional testing, and logic correctness testing.

### *A. Functional testing*

In this test, we carried out to test the suitability of the system design with the prototype results, whether the prototype was made by arrangement. The testing includes a comparison of the structure of tables, flowcharts, DFD with prototypes built.

### *B. The suitability of relations and table structure*

Besides the functional testing, we assess the suitability of relations and structure of tables between designs created with the prototype's application, compared with the database's table structure in Fig. 6.

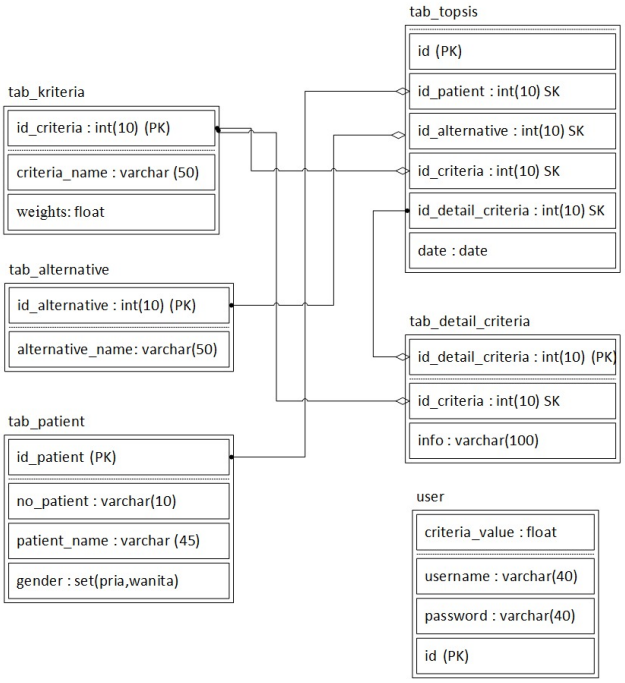



Fig. 6.Database table structure

There are some differences in relationships and the structure of the table between the design and prototype. These differences are There is a user table and id attribute in the tab TOPSIS table, in the prototype's database, but none of them in the design. It can be categorized with a good value with a weight of 3 on the table structure's suitability. While the prototype table relations are by design. The step on the prototype are as follows:

1) Add criteria data

Firstly, we will add criteria data, consist name and weights, as shown in Fig. 7.

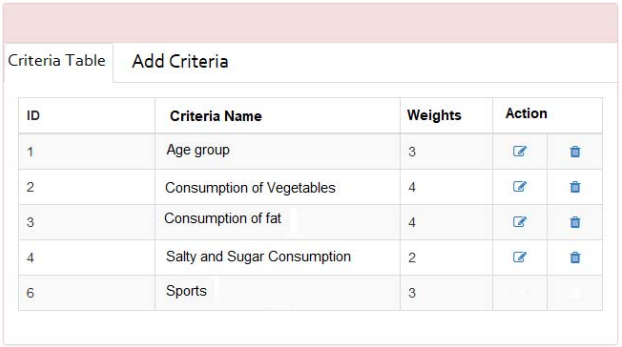



Fig. 7. Criteria data input form

2) Enter the detailed criteria data

Criteria details cannot be input without first entering criteria data in the previous process. The input form is seen in Fig. 8.

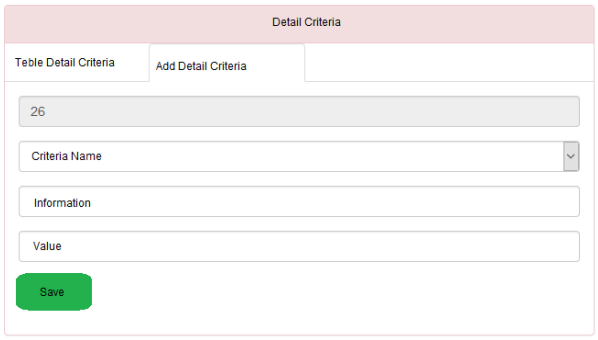



Fig. 8. Criteria data detail input form

3) Input alternative data and patients' data


Fig. 9. Alternative data input form

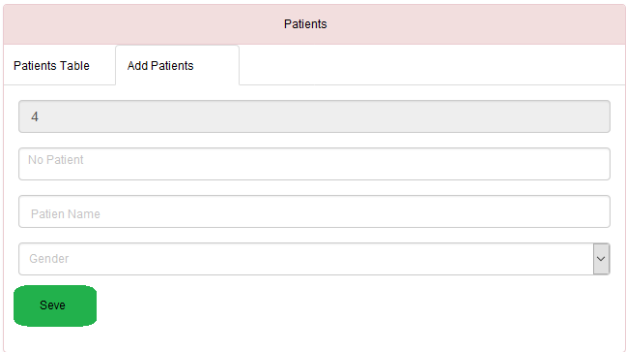



Fig. 10. Patient's data input form

The interface of alternative and patients' data can be seen in Fig. 9. and Fig. 10. This process can be done randomly, which first input either alternative or patient. Alternative data and patients can be input initially because it does not affect the previous process at points 1 and 2.

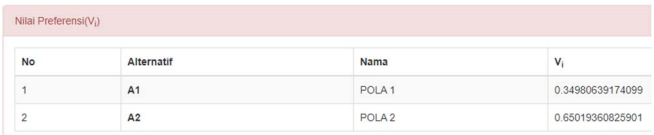
4) Enter criteria, alternatives, patient's data and criterion values.


Fig. 11. Matrix value input form

This step cannot be carried out without carrying out the previous actions, namely inputting criteria data, detailed criteria, alternatives, and patient data, as seen in Fig. 11. When pressing the process button, the data will be saved in the tbl_topsis table to continue to the next process.

5) Showing results

Point 1-4 of the design is carried out in the program code sequentially according to the TOPSIS method algorithm. However, in the system, the calculation results will appear by pressing the results menu TOPSIS. This process will show one-page results calculation results of all processes in sequence as shown in Fig. 12.


Nilai Preferensi($V_i$)

| No | Alternatif | Nama | $V_i$ |
|---|---|---|---|
| 1 | A1 | POLA 1 | 0.34980639174099 |
| 2 | A2 | POLA 2 | 0.65019360825901 |

Fig. 12. TOPSIS calculation result table

All processes mentioned in the prototype are made from the input data criteria to display the results. However, in the calculation data input process, to input one alternative and one patient which will be given by recommendations will be repeated as many times as the criteria multiplied by the number of detailed criteria.

In the user interface, all layout functions are already contained in the prototype, including a flowchart and DFD design. However, In the UI of data input matrix values, there is no edit and delete data buttons. Therefore, the data cannot be edited or deleted through the system but into the database directly.

## C. *Logical Truth Testing*

Logical truth testing aims to test the prototype system built to produce the correct value according to the formula method. This test will compare the results of early calculations using the Excel application with the prototype results. In this system prototype, the criteria and detailed criteria can be entered dynamically according to user requirements. This test was carried out with five criteria for criteria and weights, as in Table I and Table II.

TABLE I. CRITERIA AND WEIGHTS DATA

| No. | Criteria Name | Weights |
|---|---|---|
| 1. | Age group | 3 |
| 2. | Consumption of Vegetables | 4 |
| 3. | Consumption of fat | 4 |
| 4. | Salty and Sugar Consumption | 2 |
| 5. | Sports | 3 |

TABLE II. CRITERIA GRADING DATA

| Value | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| Baby | Children | Teenager | Adult | Elderly |
| Low | Less | Enough | Lots | Many |
| Low | Less | Enough | Lots | Many |
| Low | Less | Enough | Lots | Many |
| Low | Less | Enough | Lots | Many |
| Low | Less | Enough | Lots | Many |

TABLE IIII. PREFERENCE AND SCORING VALUES IN EXCEL

| | Preference Value | Rank |
|---|---|---|
| V1 | 0.3498 | 2 |
| V2 | 0.6502 | 1 |

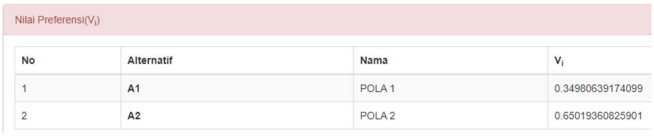



Fig. 13. Preference value on the prototype

The value generated in calculating the preference value using excel, as seen in Table III, is the same as the value generated on the prototype, as shown in Fig. 13.

## V. CONCLUSION

Based on testing a prototype of a decision support system using the TOPSIS method, we will conclude the research in this part. There is a user table in the table design, but there is no user table in the prototype. For functions or processes contained in the design, there is already a prototype. Nevertheless, in the matrix assignment form, there is no edit and delete button.

These results indicate that the prototype built using the TOPSIS method can be used to find and measure the recommended value of the nutritional pattern and lifestyle of recovered patients. The value of each pattern will be used as a recommendation for decision making in determining the nutritional pattern and lifestyle of patients recovering from COVID-19 in the province of West Nusa Tenggara (Nusa Tenggara Barat/NTB).

In this prototype, there are undoubtedly many shortcomings and can be improved in further research, as for some deficiencies. In inputting matrix values, one criterion and one patient will be repeated as many times as the criteria multiplied by the existing criteria and require more time. Nutrition recommendations are not directly displayed in the final result, but only displays the pattern's value and the name of the pattern of the recommended alternatives. Testing there are only two testing models, namely functional testing and logic correctness testing. In the future, other types of testing need to be added, such as the system's level of acceptance from the user.

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