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SMART Method: in Selecting Eco-Friendly Traditional Fishing Equipment for Fishermen in Sibolga City

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Abstract

The use of the environmentally friendly traditional fishing gear is very beneficial for fishermen in the fishing process. This needs to be implemented as an effort to maintain the sustainability of fish resources in the future. This study aims to identify the fishing gear used in Sibolga City and determine the level of environmental friendliness. The criteria for making this decision are having high selectivity (10%), not damaging habitat (25%), producing high-quality fish (15%), not harming fishermen (30%), and production not harming consumers (20%). Based on the research results, the recommendation in the first rank is Payang with a selectivity criterion value of 1, followed by drift and Dogol which have the same value, namely a high selectivity criterion of 0.5. The conclusion of this study is that the Payang, drift, and Dogol fishing gear are classified as environmentally friendly traditional fishing gear using the SMART (Simple Multi-Attribute Rating Technique) method because they can produce catches with high selectivity, minimal habitat damage, high-quality fish production, not harmful to humans. fisherman. themselves and other people around and produce fish that do not harm consumers.

Keywords: *Fishing Equipment, Eco-Friendly, SMART*

1. Introduction

Sibolga City has a strategic value as one of the main accesses to utilizing the potential of West Sumatra's water resources. Based on constant prices, the value of the Gross Regional Domestic Product (GRDP) of Sibolga City in 2011 was Rp. 777.49 billion with an economic progress rate 2011 of 5.06%[1]. For marine fisheries management areas in Sibolga which are included in WPP 572 According to statistical data (KKP, 2011) the fishery potential in Fishery Management Area 572 (West Indian Ocean, Sumatra, and Sunda Strait) is 565,100 tons/year, while fisheries production in WPP is on average 503,738 tons/year, with the remaining potential of around 61,362 tons/year. The average number of fish landings in Sibolga is 46,278.07 tons/year[2]

Sibolga City is one of the cities with a relatively large fishing industry compared to other cities on the west coast of Sumatra[3]. Coastal areas are socio-economically important because they generally make a living in the fisheries sector, including fisheries and aquaculture[4]. Fishery potential in North Sumatra is still very large. The utilization of capture fisheries in the waters of the west and east coasts has not been maximized, according to the Head of the Capture Fisheries Division of the North Sumatra Marine Fisheries Service. The development of marine wealth on the east coast is around 60-70%, and the potential for marine fisheries on the west coast is around 30-40%[5].

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Realizing a capture fisheries figure that is able to maintain and develop sustainable resource management, must apply elements of ecological sustainability, socio-economic sustainability, and community sustainability. Of these three factors, it is important to pay attention to the ecological sustainability of the available resources. [6]. Therefore, management cannot be separated from important aspects such as nutrition, economy, community, environment, and culture related to fishing activities and all stakeholders[7]. The decision to use a particular type of fishing gear depends primarily on seasonal variations and the frequency of the target fish[8].

Fishermen take various steps to get the catch obtained through genetic knowledge from their previous ancestors[9]. This knowledge includes fishing methods and fish sources by looking at the weather, waves, wind, and special clues found in outer space[10]. There are several important rules in fishing technology standards. High selectivity, harmless to fishermen, harmless to fishers, high-quality production, the product does not harm consumers, minimizes fish waste, protects or captures endangered species No, about biologically and socially acceptable diversity that minimizes impact[11].

This fishing effort is very dependent on the availability of underwater fish which cannot be predicted at a certain time. The use of fishing gear to achieve good production requires practical considerations of environmental balance and minimal side effects on the age of aquatic biota[12]. Environmentally friendly fishing activities as a reference for the use of environmentally friendly fishing tools and techniques. This condition is seen in operational practices, building materials and equipment, fishing grounds, and the availability of fish stocks while maintaining the integrity of the biota[7].

This Decision Support System aims to provide information, guide, predict and direct information users to make better decisions[13]. Determination of alternative values for each criterion is done by assigning a value to each criterion based on its effect on the selection recommendations[14]. Multi-criteria decisions are based on the theory that each alternative consists of a number of criteria that have a value and each criterion have a weight that describes how important the attribute is compared to other criteria[15].

The selection of environmentally friendly traditional fishing gear is not an easy matter, why is that? This is because the development of fishing gear technology has an impact on fish resources and fishermen themselves. Therefore, a decision support system for the selection of environmentally friendly traditional fishing gear is needed. This study aims to implement a Decision Support System (DSS). The selection of traditional fishing gear will also make it easier for fishermen to choose good fishing gear, do not damage the ecosystem and the results obtained are also satisfactory. The criteria used in this system are the level of selectivity of fishing gear, quality of catch, and level of safety of fishing gear. Referring to the statement, it can be concluded that fishing operations can be said to run smoothly if a fishery business has several criteria for environmentally friendly fishing technology.

In determining the level of selection of environmentally friendly traditional fishing gear using the SMART method which is able to choose the best alternative from several alternatives. SMART is a flexible decision-making method[18][19]. The SMART (Simple Multi-Attribute Rating Technique) method is a method that can calculate things that are both qualitative and quantitative[20]. This multi-attribute decision-making technique is used to support decision-makers in choosing among several alternatives according to the objectives that have been formulated[21][22]. SMART is more widely used because of its simplicity in responding to the needs of decision-makers and the way to analyze responses[23][24]. This multi-criteria decision-making technique is based on the theory that each alternative consists of a number of criteria that have a value and each criterion have a weight that describes how important it is compared to other criteria[25]. In other words, the way the SMART method works is that it combines all of the criteria to help focus efforts on increasing the chances of achieving goals.

2. Reseach Methods

2.1. Research Stage

In this study, several stages were carried out as follows:

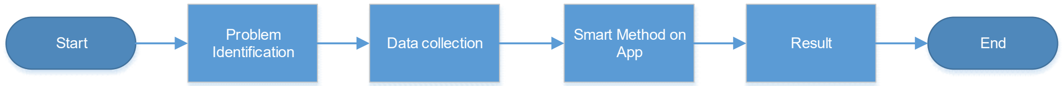

Figure 1. Research Stage

This research was conducted at PPN Sibolga which is located on Jalan Gatot Subroto, Sibolga City with the research subjects being fishermen in PPN Sibolga. Data collection methods used in this study were observation, interviews, and documentation. In the decision-making process, decision-makers are often faced with various problems originating from various criteria.

The decision support system model for selecting environmentally friendly traditional fishing gear for fishermen in Sibolga has 5 main criteria. Where each criterion has its own weight which will determine the final result of the decision support system that will be used by enthusiasts in determining a decision. Each assessment's weight varies depending on the results of the type of model.

The determination of weight of the assessment has been carried out based on the criteria that have been determined based on the results of the study and further changes can be made according to the demands of the needs. The system in the assessment process refers to the fulfillment of predetermined criteria and refers to several cases that occur so that it has a good benchmark.

2.2. SMART method

SMART (Simple Multi-Attribute Rating Technique) is a multi-criteria decision-making method developed by Edward in 1997. This multi-criteria decision-making technique is based on the theory that each alternative consists of a number of criteria that have a value and each criterion have the same weight. illustrates how important it is compared to other criteria. This weighting is used to assess each alternative in order to obtain the best alternative [27].

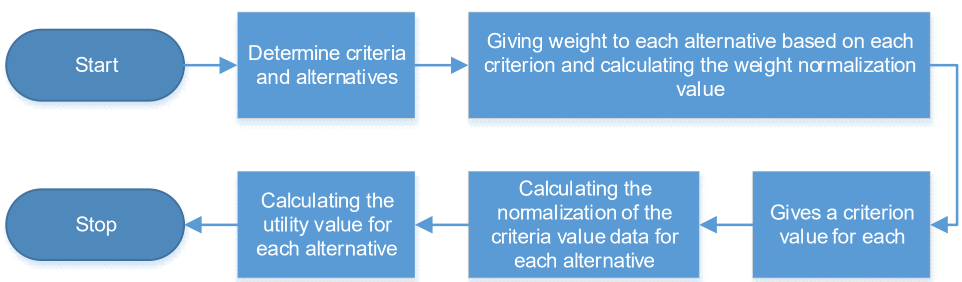

Figure 2. Stages of the SMART method

1. Determine the criteria and alternatives used in solving decision-making problems.
2. Give weight to each criterion by paying attention to the most important priority.
3. Provide a criterion value for each alternative, the criterion value for each alternative can be in the form of quantitative data (numbers) or in the form of qualitative data. Furthermore, the normalization of the criteria weights is carried out. The initial weight in percent is normalized by the formula:

$$nwj = \frac{Wj}{\sum_{n}^{k}=1W_n} \quad (1)$$

Description:
• is the normalization of criterion weight j
• j is the weighted value of the criteria j
• k is the number of criteria
• n is the weight of the nth criterion

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4. Give a value for each sub-criteria that will be the utility value. Or calculate the utility value for each sub-criteria.

$$Ui(ai) = \frac{Cout - Cmi}{Cmax - Cmin} \quad (2)$$

Description:
- ui(αi) : utility value of the 1st criterion for the i-th criterion
- Cmax : maximum criterion value
- Cmin : minimum criteria value
- Couti : i criteria value

5. Calculate the final value using the SMART formula.

$$u(ai) = \sum_{j}^{m} = iWjUi(ai) \quad (3)$$

Description:
- u(αi) : total value of alternatives
- wj : result of normalization of criterion weight
- ui(αi) : the result of determining the utility value

3. Result and Discussion

The results and discussion contain the SMART process design and WEB-based SMART implementation which will be explained in the next sub-chapter.

3.1. SMART Method Design

The system designed in this research is a Decision Support System for Selection of Environmentally Friendly Traditional Fishing Equipment by applying the SMART Method. In applying the SMART method, there are several things that need to be done before calculating the value, one of which is:

1. Determine the Assessment Criteria
   There are 5 criteria obtained from fishermen in Sibolga City, namely:
   a) Has high selectivity (C1)
   b) Does not damage habitat (C2)
   c) Produce high quality fish (C3)
   d) No harm to fishermen (C4)
   e) Production does not harm consumers (C5)
2. Determining Criteria Weight
   Determine the weight of the criteria for each criterion by using an interval of 1-100 for each criterion with the most important priority.

Table 1. Criteria Weight

No	Kriteria
1	C1
2	C2
3	C3
4	C4
5	C5
Jumlah	100

3. Calculating Normalization
   After getting the value for each criterion, normalization is carried out, namely by dividing the weight value of the criteria by the number of values using equation [28].

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Table 2. Normalization Results

No	Criteria	Weight	Result
1	Has high selectivity	10	10/100=0,1
2	Does not destroy habitat	25	25/100=0,25
3	Produce high quality fish	15	15/100=0,15
4	No harm to fishermen	30	30/100=0,3
5	Production does not harm consumers	20	20/100=0,2

4. Provide Parameter Value
   Gives a criterion value on all alternatives. These values can be seen in table 3.

bvchfTable 3. Criteria Value Configuration

No	Criteria	Sub Criteria	Sub Criteria Value
1	Has high selectivity	• Fishing gear of the same size • Fishing gear of approximately the same size • Fishing gear with far different sizes	3 2 1
2	Does not destroy habitat	• Safe for habitat • Causes habitat destruction in narrow areas • Causes habitat destruction over large areas	3 2 1
3	Produce high quality fish	• live fish • Dead and fresh fish • Dead fish, fresh and physically disabled • Dead and rotten fish	4 3 2 1
4	No harm to fishermen	• Safe fishing gear for fishermen • Fishing gear and how to use it can result in temporary health problems for fishermen • Fishing gear and how to use it can result in permanent (permanent) disability for fishermen • Fishing gear and how to use it can cause death to fishermen	4 3 2 1
5	Production does not harm consumers	• Safe for consumers • Chance to cause consumer health problems • High chance of causing consumer death	3 2 1

5. Determine the Utility Value
   The criteria values are then converted into a standard data criteria value to determine the utility value obtained from equation [28]. Can be seen in table 4

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Table 4. Utility Value Configuration

Criteria Value	Utility Value
4	1
3	0,75
2	0,50
1	0,25
0	0

6. Determine the Final Result

Calculate each alternative value using the equation formula. By converting the utility value to the normalized value of the criteria weights, the final value is obtained. Calculations made by fishermen's input and the value of each fishing gear are obtained from the same process. The value that is close to the last input value of the fishermen and the value of each fishing gear is the recommendation for the best fishing gear for fishermen.

3.2. System Analysis and Design

Analysis and design are carried out using use case diagrams, activity diagrams, sequential diagrams, and class diagrams as follows:

1. Use Case Diagrams

The following analysis and design of use case diagrams:

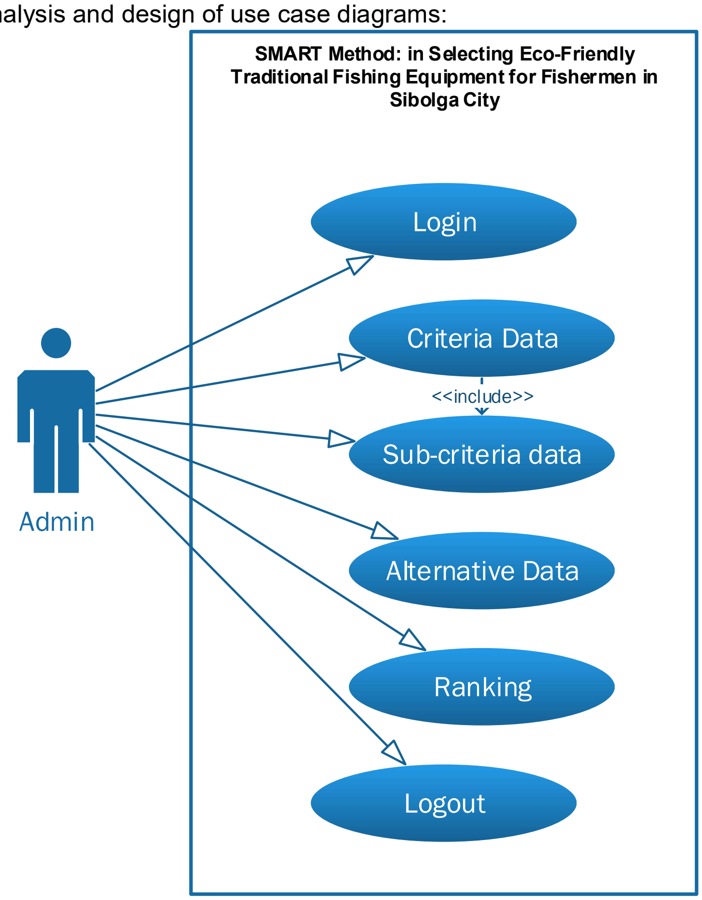

Figure 3. Use case for traditional fishing gear

Figure 3 above shows the use case diagram owned by the admin actor, namely Login, Criteria Data, Sub Criteria Data, Alternative Data, Ranking and Logout.

2. Activity Diagram

The following is the analysis and design of activity diagrams:

Figure 4. Activity Diagram for traditional fishing gear

Figure 4 above shows the admin activity diagram, namely logging in, accessing criteria data, accessing alternative data, and ranking

3. Sequential diagrams

The following analysis and sequential diagram design:

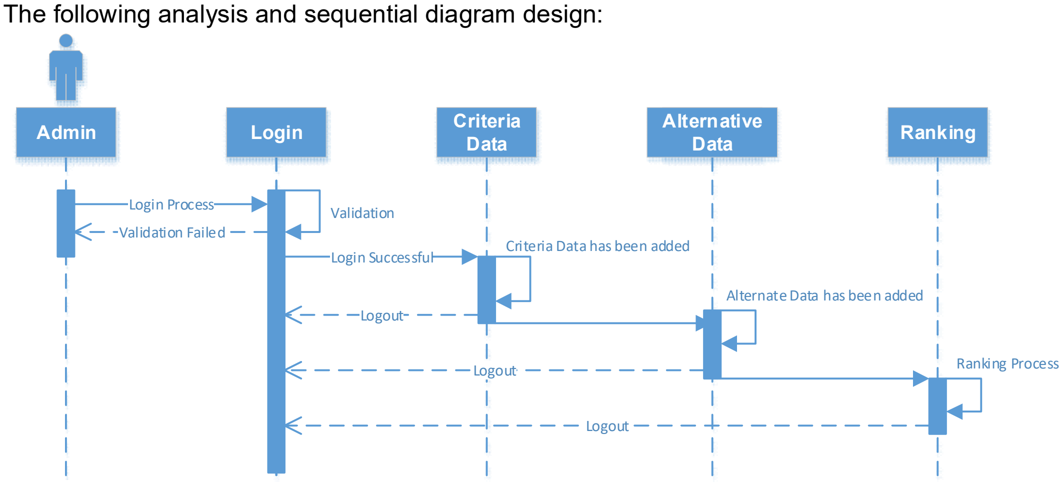

Figure 5. Sequential Diagrams for traditional fishing gear

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Figure 5 above shows an admin sequential diagram, namely login validation messages, criteria data access messages, alternative data access messages, and ranking messages.

4. Class Diagrams

The following analysis and class diagram design:

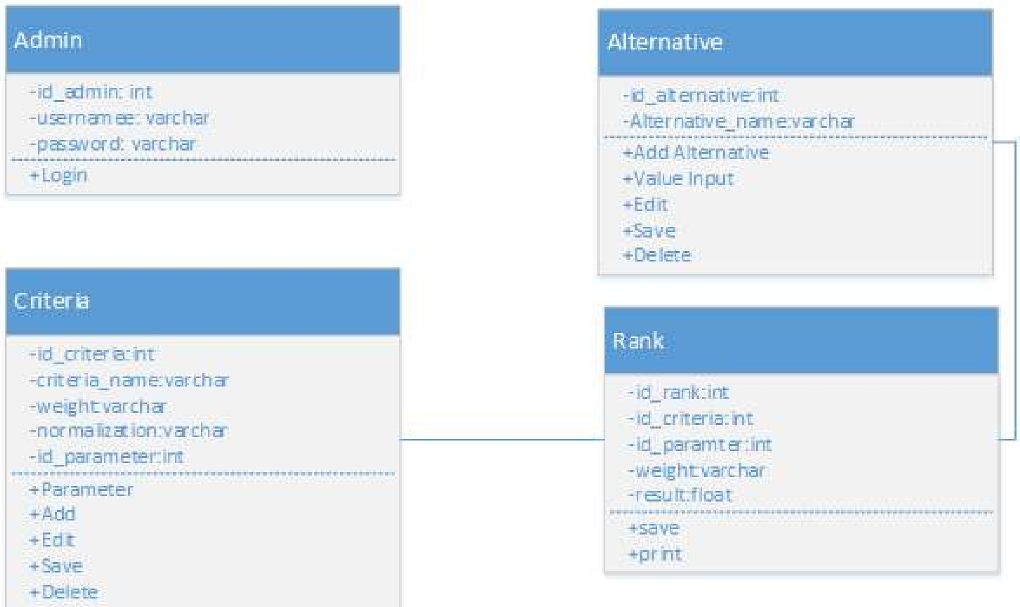

Figure 6. Class Diagrams for traditional fishing gear

Figure 6 above shows the class diagram of the system design in the image that shows the association relationship between the criteria class or alternative class and the ranking class

3.3. System Implementation

At this stage, the SMART (Simple Multi Attribute Rating Technique) method is used to determine recommendations for environmentally friendly traditional fishing gear for fishermen in Sibolga City, implemented into a WEB-based application. The results of the WEB-based implementation are as follows.

Figure 7. Login Page

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The admin inputs the username and password that have been provided. Then the admin logs in by clicking the login button and the system will enter the dashboard page.

Data Kriteria

Show 10 entries Search:

No	Kriteria	Bobot	Normalisasi	#
1	Mempunyai selektivitas yang tinggi	10	0.10	Parameter Edit
2	Tidak merusak habitat	25	0.25	Parameter Edit
3	Menghasilkan ikan yang berkualitas tinggi	15	0.15	Parameter Edit
4	Tidak membahayakan nelayan	30	0.30	Parameter Edit
5	Produksi tidak membahayakan konsumen	20	0.20	Parameter Edit
	Σ Total	100		

Figure 8. Criteria Data Page

Then on the criteria data page, here there are 5 criteria listed in Figure 8. On this page the admin can add parameters and also edit criteria. Then on this page the program processes the normalization results of each criterion weight, with the weight formula divided by the total weight. The number of weights before normalization is 100 and after normalization is 1.00.

Rank	Nama Alternatif	Hasil
1	payang	8.00

Kriteria	Nilai	Bobot	Cmax-Couti(a)	Cmax-Cmin (b)	a/b
Mempunyai selektivitas yang tinggi	1	0.1	0.9	0.5	1.80
Tidak merusak habitat	0.5	0.25	0.75	0.5	1.50
Menghasilkan ikan yang berkualitas tinggi	1	0.15	0.85	0.5	1.70
Tidak membahayakan nelayan	0.5	0.3	0.7	0.5	1.40
Produksi tidak membahayakan konsumen	1	0.2	0.8	0.5	1.60

Rank	Nama Alternatif	Hasil
2	hanyut	8.00

Kriteria	Nilai	Bobot	Cmax-Couti(a)	Cmax-Cmin (b)	a/b
Mempunyai selektivitas yang tinggi	0.5	0.1	0.9	0.5	1.80
Tidak merusak habitat	0.5	0.25	0.75	0.5	1.50
Menghasilkan ikan yang berkualitas tinggi	1	0.15	0.85	0.5	1.70
Tidak membahayakan nelayan	0.5	0.3	0.7	0.5	1.40
Produksi tidak membahayakan konsumen	1	0.2	0.8	0.5	1.60

Figure 9. Ranking Pages

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In Figure 9, this is a ranking page of the value input process carried out on the previous alternative data. To find the final result, it is necessary to multiply the normalized value of the weight with the utility value. So that from several alternatives that have been inputted their respective values are then processed by the program. Then the recommendations for the best traditional fishing gear can be found. The recommended fishing gear both have the same result, namely 8.00. Because they both have the same result value, we are here selecting through criteria that have high selectivity. The recommendation in the first rank is Payang with a selectivity criterion value of 1, followed by drift and Dogol which has the same value, namely the high selectivity criteria, which is 0.5, then in the fourth and fifth places there are ring seines and beach trawls which have the same total results, namely 4.0.

3.4. BlackBox Test

BlackBox testing on this system can be seen in the table below:

Table 5. BlackBox Test

Application Name: SMART Method: in Selecting Eco-Friendly Traditional Fishing Equipment for Fishermen in Sibolga City			Tester : Admin		
	Tested Pages	Actor Action	System Reaction		Result
			True	False	
1.	Admin Homepage	Click the Login Button	Login to the Admin Login Page	Not Entering the Admin Login Page	As Expected (Valid)
2.	Criteria Data Manage Page	Entering Criteria Data	Criteria data can be added	Criteria data cannot be added	As Expected (Valid)
3.	Alternative Data Manage Page	Entering Alternative Data	Alternative data can be added	Alternative data cannot be added	As Expected (Valid)
4.	Manage Ranking Page	Ranking Process	The ranking process was successful	The ranking process failed	As Expected (Valid)
5.	Logout	Click Logout On Page Dashboard	Logout and Display the Homepage	Not Logout	As Expected (Valid)

4. Conclusion

The results of the application of the SMART method in the selection of environmentally friendly traditional fishing gear for fishermen in the city of Sibolga are based on the criteria of having high selectivity, not destroying habitat, producing quality fish, not harming fishermen, and not dangerous production. consumers, who are considered by the Head of PPN to choose the best traditional fishing gear for fishermen in Sibolga. The final result that is expected is to obtain the best fishing gear for fishermen in Sibolga City based on predetermined criteria.

Based on the results and the total comparison of the manual calculations and the program above, Payang is the best first alternative, then other alternatives such as drift and Dogol can be obtained. With the use of recommended fishing gear, it can be ensured that the fishing gear can produce catches with high selectivity, minimal habitat damage, produce quality fish, do not endanger the fishermen themselves or other people around and produce fish that are not harmful. consumer.

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