# Identification of Fishermen Household's Adaptive Capacity in Responding to Climate Change Impacts

## (A Case Study of Muncar District, Banyuwangi Regency, Indonesia)

**Fitriawati[1], Djoko Santoso Abi Suroso[2]**

[1,2]*Urban and Regional Planning, Bandung Institute of Technology, Bandung, Indonesia*
*bismillahfitri@gmail.com*

## Abstract

Climate change affects the uncertainty of oceanographic condition that has an impact on the marine fisheries, such as changes in fishing areas, winds, and extreme waves. As an archipelagic country, the majority of Indonesian cities are in the coastal area whose the community's livelihood depends on marine fishery activities. Climate change impacts the coastal community who engages in fishery activities are now being vulnerable group towards climate change. This condition is also experienced by fishermen in Muncar District, the second biggest fishery port in Indonesia. It is necessary to enhance fishermen household's adaptive capacity which is the key to region's resilience. This research focuses on adaptive capacity assessment by formulating criteria and indicators based on the expert's theories review. The method that is used in this research is statistic descriptive based on a questionnaire which distributed to 120 households samples. This research also views perception of fishermen on climate change impacts and on how Local Government Units (LGUs) and Community Organizations (COs) support the increase of fishermen household's adaptive capacity. The result of the assessment showed that 56% of households have 'medium' adaptive capacity, 34% of them are in 'low' adaptive capacity, and 10% households are in 'high' adaptive capacity. The LGUs and COs gives a high endorsement to households to increase their adaptive capacity. The result of this study can be taken into consideration in formulating the strategies to enhance fishermen household's adaptive capacity in order to realize the resilient fishermen households socially and economically.

Keywords: adaptive capacity; climate change; fishermen household; marine fishery

## 1. Introduction

Global warming is an important issue that is considered causing climate change which has major impacts on the various sectors of public life in the world including Indonesia, such as agriculture, health, water resources, and marine and fisheries (BAPPENAS, 2010). There are many climate change impacts on marine fisheries sector such as the changes of Southeast monsoon, fishing area, and fish migration pattern; the increase of frequency and intensity of storms and extreme waves in the ocean; and the changes in rainfall (D'Silva, Shaffril, Samah, & Uli, 2012; Sissener & Bjorndal, 2004).These conditions affect mostly the livelihood of a coastal community in Indonesia such as fishermen. They experience the difficulty in determining the fishing season and areas, face higher sailing risks and the uncertainty of the one-day fishing result.

Banyuwangi Regency is one of cities or regencies in East Java Province which has the long coastal line. Muncar district is a district in Banyuwangi whose community is mostly fishermen. This district was designated as fishery port and Minneapolitan area. The fishery processed products in Muncar are not only

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[1] Corresponding Author: Department of Urban and Regional Planning, Bandung Institute of Technology, Indonesia
Email: bismillahfitri@gmail.com

for fulfilling national needs but also being exported to several parts in the world such as USA, Europe, Australia, Japan, Malaysia, and Thailand (Ministry of Maritime and Fisheries Affairs, 2010).

The marine fisheries production in Muncar has fluctuated and it tends to be decreased significantly since 2011. According to Hendiarti et al. (2005), the seasonal fishing is strongly related to oceanographic conditions. Geographically, the characteristic of Bali Strait, a fishing ground for mostly fishermen in Muncar District, is highly influenced by the Indian Ocean which has a complex condition of the confluence of several currents. In addition to the changes of monsoon wind pattern which affect the fishing production, there is also potentially the increase of extreme waves' frequency and intensity.

The adaptive capacity is an ability of a community to design and to implement effective adaptation strategies or to react to the hazards and stresses in order to reduce the likelihood of the occurrence and/or the magnitude of damages which are resulted by climate-related hazards (Penalba & Elazegui, 2011). According to BAPPENAS (2010), the adaptive capacity is a component of the vulnerability which refers to the ability of humans or the environment to react and adapt in reducing a hazard so there is no greater loss. Adaptive capacity describes the ability to cope the changes that are happening and predicted to occur. From both definitions, this paper argues that adaptive capacity is an ability of a system to modify the characteristics or behavior to adjust or adapt for now reducing the loss and take advantage of opportunities that will occur in the future caused by climate change.

Planning for and implementation of adaptation should be increased between levels or complement each other from an individual or household to the government (IPCC, 2014). Multi-stakeholders adaptation to climate change implies that the solution lies not only in the single actor but it is a concern of all affected actors (Liverani, 2009). Similarly, the adaptive capacities are not separated but complement each other, the households' capacity is also determined by the support of the other stakeholders (Smit & Wandel, 2006). As a result, the assessment of the adaptive capacity of an area can be viewed from three stakeholders as following (Penalba & Elazegui, 2011):

a.  The local government as decision makers of the policy, the higher the readiness of local government the higher the adaptive capacity of the region;
b.  The local organization, a better owned social capital can increase the adaptive capacity of the region; and
c.  The household, as a party which is directly affected so that is being the key factor in determining the resilience of the region.

D'Silva et al. (2012) explained that the intervention to reduce the risk of fishermen community toward climate change is by increasing the adaptive capacity. Adaptive capacity is referred to the ability of the community to arrange and to implement the effective strategies to adjust climate change and to decrease potential loss. Among three stakeholders such as Local Government Units (LGUs), Community Organizations (COs), and households, the household is the important key for increasing the resilience of the region. The higher adaptive capacity of households, the higher the resilience of region (D'Silva et al., 2012). It is necessary to assess the adaptive capacity of fishermen household for knowing their ability to decrease the potential loss and to take the advantage of opportunities which will be created by climate change in the future.

This study explores "how is the adaptive capacity of fishermen's household in Muncar District to respond to climate change impacts?" This study was conducted to assess the level of adaptive capacity of fishermen household and to identify the role of LGUs and COs for increasing fishermen household's adaptive capacity. The result of this research is expected to be a consideration to inform the multi-stakeholder adaptation strategies in responding to climate change impacts in Muncar District. However, it is difficult to find studies that provide a framework for assessing the fishermen household's adaptive capacity so it is necessary to determine the criteria as well as their indicators in accordance with the context of this study. Thus, this paper presents a framework which represents a compilation of theories of Penalba and Elazegui (2011); Swanson, Hiley, Venema, and Grosshans (2009); Wall and Marzall (2006). These three theories provided frameworks in assessing the adaptive capacity in the agriculture and disasters. Therefore, they are then modified by the addition of appropriate indicators (to marine fisheries) and the reduction of inappropriate indicators (to marine fisheries). From reviewing those three studies, a framework to assess the adaptive capacity of fishermen household in Muncar District is established (see Table 1).

Table 1: Framework for Adaptive Capacity Assessment of Fishermen Household in Muncar District

| Criteria | Indicator | Type of Question |
|---|---|---|
| Economic Resources | The stability of household financial condition | Having the other household's income sources than marine fishery-related |
| | | Having the other livelihood options that are not related to marine fishery |
| | | Household's average income per month |
| | | Expenditure doesn't exceed the household's average income per month |
| | | Savings (low borrowing needs) |
| | Asset ownership | Owning the property rights of house |
| | | Owning the other assets which are owned by household |
| | | Having many relatives especially who have livelihood on non-marine fishery (potential sources of loan) |

| Criteria | Indicator | Type of Question |
|---|---|---|
| Social Capital | Participation in the community groups | Being a member of fishing community<br>Interacting with other members of the same community through participation in the community's activities<br>Willingness to follow the agenda of discussions related to fishery and climate change |
| | Access to assistance | Having the sources of assistance (goods and or money)<br>Having the experiences of marine fishery-related training |
| Information and Technology | Production facilities | Using high-capacity boat |
| | Information related to climate change | Having the information medias<br>Obtaining the daily weather information |
| | Attitude determination facing marine treats | Optional action in danger and inhibited fishing activity |
| Infrastructure | Access to the port facilities | Utilizing the provided facilities at the fishery port |

Source: Analysis, 2016

While in understanding the roles of the LGUs and COs in enhancing the fishermen household's adaptive capacity used a simple framework which has been reviewed by Penalba & Elazegui (2011). Table 2 describes the three criteria of the framework. The first criterion considers how the coordination between teams/ units in dealing with the issue of climate change and how the Local Government Unit (LGU) links with other possible institution partners in addressing climate change. The second criterion explores programs that can enhance the adaptive capacity and how the climate change issues become one of the considerations in formulating programs. The third criterion explores the allocation of budget and human resources in coping the impacts of climate change.

Table 2: Framework for Understanding the Roles of Local Government Units (LGUs) and Community Organizations (COs)

| No. | Criteria | Description |
|---|---|---|
| 1. | Framework and structure | To see how the organization structure is set up to deal with the effects of climate change |
| 2. | Program | To see how climate change issues are considered in formulating policy and programs |
| 3. | Financial and human resources | To see how funds and human resources are allocated to deal with the impact of climate change |

Source: Penalba & Elazegui (2011)

## 2. Methodology

This research used the mixed method approach, which the quantitative as the main method. The qualitative method approach is also used in order to produce the comprehensive study of fishermen household's adaptive capacity.

### 2.1 Data Obtaining

The secondary data is collected by collecting time series data in the related institution about climate change impacts toward marine fishery such as fish catchment data, the number of vessels, and another data related to the characteristic of Muncar District geographically, socially, and economically. The primary data is obtained by distributing questionnaires, interviewing informants, and conducting direct observation. The questionnaires were designated to the head of the family who works as a fisherman. There are 120 sample households have been chosen using Slovin formula (with a number of population is 20,235 people and using 10% errors):

$$n = \frac{N}{N \cdot d^2 + 1}$$

where
n : number of samples
N: population
d: *error sampling*

Cluster random sampling technique is used since there is no sample framework such as individual names or house number**.** Tembokrejo Village was chosen as cluster sample. Then, systematic random sampling also couldn't be implemented in this research so that the numbers of respondents in each sub-district were counted proportionally to the number of fishermen. Some RWs (the units under sub-district) in each sub-district whose community are mostly fishermen were chosen. Table 3 shows the number of respondents of each sub-district in Tambakrejo Village. This study also conducted in-depth interviews to some key informants who having a deep understanding on this topic. It followed by direct observation to obtain general characteristics of the study area and fishermen's characteristics including fishermen's activities, provided facilities, the kind of fishing tools and vessels**,** and the condition of fishery port.

Table 3: Number of Respondents Each Sub-District of Tembokrejo Village

| No. | Sub-District | Number of Fishermen (people) | Number of Proportional Samples (people) |
|-----|-------------|------------------------------|------------------------------------------|
| 1 | Muncarbaru | 2,796 | 27 |
| 2 | Palurejo | 3,750 | 36 |
| 3 | Muncar | 3,500 | 34 |
| 4 | Krajan | 2,454 | 23 |
| | **Sum** | | **120** |

Source: Analysis, 2016

## 2.2 Data Analysis

The analysis method used is quantitative descriptive statistic analysis by presenting data as the results of questionnaires' processing through organizing and concluding the information by examining each of study variables. Analysis method was used to present data which are related to fishermen characteristics, indicators of adaptive capacity, and assessment of the adaptive capacity level of fishermen household.

The scoring technique is used to give the value for the four criteria and indicators chosen in this study (see Table 1). The maximum score of adaptive capacity is 100. Each criterion has the maximum value of 33.3 (infrastructure criteria is united with information and technology criteria in the adaptive capacity level assessment particularly in order to avoid the bias). The maximum value per criteria was divided by the number of each question in order to obtain the maximum value of the answer options per question as shownin Table 4.

Table 4: Score of Each Answer Option

| Criteria | Number of Questions | Maximum Score of Answer Option Each Question |
|----------|---------------------|----------------------------------------------|
| Economic resources | 8 | 4.16 |
| Social capital | 5 | 6.66 |
| Information and technology Infrastructure | 5 | 6.66 |
| **Total of questions** | **18** | |

Source: Analysis, 2016

The maximum scores of the answer options then distributed into several answer options based on the priority which specified as an answer that had the highest score of each question. Through the calculation, the maximum value of each criterion used to assess the adaptive capacity. It was necessary to determine the classes and interval length to categorize the level of adaptive capacity by the following formula.

> The number of the classes (K) = 1+3.3 Log (n)
> Interval length (I) = R/K

Where:
n: the number of data (questions)
R: range or the difference between the highest and the lowest value

From the results of the calculation of the number and interval of classes then obtained the following classifications as shown in Table 5. Furthermore, to assess the adaptive capacity of fishermen household as a whole then carried out the same formula but with the number of data were 18 according to the total number of questions in a questionnaire.

Table 5: Class of Division and Interval Length each Criterion and the Score per Class

| Interval | Class | Score |
|----------|-------|-------|
| **Economic Resources** | | |
| 4.0 – 10.0 | Very Low | 0 |
| 10.1 – 16.1 | Low | 0.5 |
| 16.2 – 22.2 | High | 1.5 |
| 22.3 – 28.3 | Very High | 2 |
| **Social Capital** | | |
| 0.0 – 11.0 | Low | 0 |
| 11.1 – 22.1 | Medium | 1 |
| 22.2 – 33.2 | High | 2 |
| **Information and Technology, Infrastructure** | | |
| 13.0 – 19.7 | Low | 0 |
| 19.8 – 26.5 | Medium | 1 |
| 26.6 – 33.3 | High | 2 |

Source: Analysis, 2016

Table 6 shows the results of clustering the adaptive capacity of fishermen household. In addition, the qualitative descriptive analysis was employed to understand how the role of the LGUs and COs in supporting the adaptive capacity of fishermen households. The roles of these two stakeholders were grouped into the framework and structure, programs and financial and human resources, which were arranged into a table based on the support to each criterion (economic resources, social capital, information and technology, and infrastructure).

Table 6: Classification for the Adaptive Capacity Level of Fishermen Households

| Interval | Class |
|----------|-------|
| 0.5 – 2.2 | Low |
| 2.3 – 4.0 | Medium |
| 4.1 – 5.8 | High |

Source: Analysis, 2016

## 3. Analysis
### 3.1 The Adaptive Capacity Level

Figure 1 shows the results of the analysis about adaptive capacity of fishermen household viewed by economic resources criteria. Figure 1 shows that almost half of the population (47%) has the very high and high adaptive capacity. It categorized in medium level. It means that almost half of the population has a good capacity to respond the climate change impacts by maintaining the stability of financial condition and having assets that can be used as the last alternative if the financial condition is getting worst.
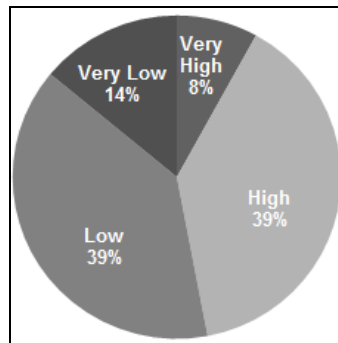


Figure 1. Percentage of Fishermen Household's Adaptive Capacity from the Economic Resources Criteria

Based on the indicators of economic resources, the majority of household (nearly 90%) has the valuable assets which can help their finance although most of the households did not have other income sources and their total income per month is below the minimum wage in Banyuwangi. Furthermore, the households who live in their own house will relatively have less expenditure than the households who still allocate for the rental fee each month. The households who have other valuable assets such as a motorcycle, garden, jewelry, etc can use the assets as the last alternative to earn the living if the financial condition is getting worst due to the difficulty in getting fish.

Nevertheless, there are still 39% and 14% of households that have the low and very low adaptive capacity. It is influenced by the number of households that still do fishery as the only source of family income, only the head of household who earn the living, and they have no job alternative when they cannot go for fishing. In addition, due to the uncertain revenue, many households that have very low and low adaptive capacity in the economic resources criteria also due to lack of a willingness to save.

Based on social capital criteria, Figure 2 shows that as much as 59% respondents are categorized as having 'low' adaptive capacity. Meanwhile, only 23% of households have the high adaptive capacity and 18% have a medium level. It shows that more than half of the population still has the low social capital to respond to the climate change impacts on the marine fisheries.

The low level of social capital criteria means that the participation of the community is still low. Almost half of the respondents have been a member of fishermen group but there are some fishermen rarely or never attend the group's activities such as discussion and training. Fishermen groups in Muncar District, called as KUB (*Kelompok Usaha Bersama*) are supposed to be a forum of interaction between fishermen to exchange ideas. Therefore, the members who never attend group's activities did not have the opportunity for getting new information, knowledge, and even the goods and training assistance. In addition to the less participation, the cause of low adaptive capacity is inactive of some fishermen after got the assistance. These groups were formed by fishermen as a requirement to get the assistance only. Based on these problems, it is necessary to increase the role of KUB in enhancing the adaptive capacity of fishermen household and the role of the LGUs especially Marine and Fisheries Agency to encourage the participation of fishermen groups.
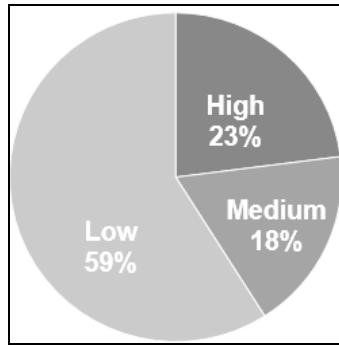
Figure 2. Fishermen Households' Adaptive Capacity from the Social Capital Criteria

Figures 3 shows that 21% of households have the low adaptive capacity, more than half of the households have medium, and 26% of households have high adaptive capacity viewed by information, technology, and infrastructure criteria. It categorized as good condition as most of the population has a high and medium adaptive capacity. It means that the majority of households are relatively capable of adapting to the climate change impacts based on the information, technology, and infrastructure criteria.
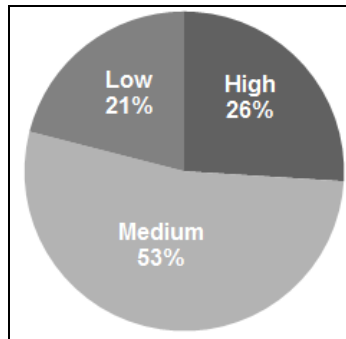


Figure 3. Percentage of Fishermen Household's Adaptive Capacity from
the Information, Technology, and Infrastructure Criteria

Based on the indicators of information, technology, and infrastructure criteria, one of the indicators that affect many households still having medium adaptive capacity is the information system. The information about weather is delivered only to a few fishermen. As a result, when fishermen experience the extreme weather at the sea, many of them decide to go home. Considering the fact that the majority of the population has the medium adaptive capacity, it is necessary to develop the information system and to increase the accessibility of fishermen households to the information and technology as well as to the fishery port facilities.

**3.2 Synthesis of the Adaptive Capacity of Fishermen Household**

This section presents the results of the assessment of fishermen household's adaptive capacity as a whole. The level of adaptive capacity is divided into three classes as shown in Table 7 in order to be more clearly visible. Based on the results of the final assessment as shown in Table 7, the majority of fishermen households in Muncar District (55.83%) have the medium adaptive capacity. Nevertheless, there are still households who have 'low' adaptive capacity (34.17%) and only 10% of the population who categorized as the high level of adaptive capacity. Therefore, it is necessary to increase the adaptive capacity of fishermen households since they positioned as the most important stakeholder in order to encourage the resilience of the region towards climate change. Nevertheless, the adaptive capacity scales are not independent and separated because the adaptive capacity of households is also determined by the other stakeholders.

Table 7: Classification for the Fishermen Household's Adaptive Capacity

| Interval | Class | Percentage of Respondents (%) |
|---|---|---|
| 0.5 – 2.2 | Low | 34.17 |
| 2.3 – 4.0 | Medium | 55.83 |
| 4.1 – 5.8 | High | 10.00 |
| **Total** | | **100** |

Source: Analysis, 2016

### 3.3 Roles of Local Government Units and Community Organization

This section presents the roles of the Local Government Units (LGUs) and community organization (fishermen groups or KUBs) in enhancing the fishermen household's adaptive capacity. Table 8 shows the roles mapping of these two institutions by using a framework which is explained in literature review section.

Table 8: Role Classification of LGUs and Fishermen Groups in Supporting the Adaptive Capacity of Fishermen Household in Muncar District

| Support for: | Local Government Units (LGUs) | | |
| --- | --- | --- | --- |
| | Framework and Structure | Program | Financial and Human Resources |
| 'Economic Resources' Criteria | - Marine and Fisheries Agency (DKP) of East Java has the technical implementation unit (UPT) in Muncar fishing port which has the duties in fishery port management, fishing monitoring, and technical services of a fishing vessel.<br>- DKP Banyuwangi has UPT as a fishing counselor at Muncar District | - Giving the assistance such as money, production facility, and training to the fishermen groups<br>- Programs to provide alternative employment for the fishermen | The budget for giving the assistance and coaching to the fisherman groups is available but it has uncertain nominal because it depends on by proposals which are proposed by KUBs. The allocation of the fund is gotten from district budget, provincial budget, and the state budget. |
| 'Social Capital' Criteria | | Group coaching programs | |
| 'Information and Technology' Criteria | | - Provision of information via website related to the weather and marine forecasts as well maps of fishing ground<br>- Dissemination of information via SMS to some fishermen, KUBs, and sea/land skippers<br>- Aid to the sank vessel | There has been no budget for disseminating information related marine conditions to the fishermen and KUBs via SMS. |
| 'Infrastructure' Criteria | | Full facilities to support the activities of fishery in Muncar District | Allocation of funds is obtained from the district budget, provincial budget, and state budget. |

| Support for: | Fishermen Group (KUBs) | | |
| --- | --- | --- | --- |
| | Framework and Structure | Program | Financial and Human Resources |
| 'Economic Resources' Criteria | KUB is a legal group and then become the coached group of DKP Banyuwangi. | - Management of assistance utilization<br>- Saving program in KUB<br>- KUBs that is still active usually held regular meetings internally<br>- Attending training or socialization of the government agencies | The group financial resources are obtained from member's cash. Further, it is earmarked for KUB's activities also are being member's loan sources. |
| 'Social Capital' Criteria | | | |
| 'Information and Technology' Criteria | | The roles of fishermen groups have not been looked. | - |
| 'Infrastructure' Criteria | | The roles of fishermen groups have not been looked. | - |

Source: Analysis, 2016

Table 8 informs that on the economic resources criteria, the LGUs have a role in giving assistance and alternative job while KUBs have a role in assistance management so that all members can get it equitably. But in reality, many KUBs then become inactive after receiving assistance while the active KUBs continue their regular activities. On the social capital criteria, there has been many group coaching programs to be more empowered, as well as KUBs that are still active make their members can access the information, assistance, and training easily. On the information and technology as well as infrastructure criteria, the LGUs have sought to provide information which can be accessed by fishermen, but it is necessary to develop how to deliver the information (about fishing ground and weather) to each fisherman and how to make fishermen want to access and be capable of reading the provided information. Besides providing information, the LGUs have been provided the complete facilities in the fishery port either main, functional, and supporting facilities.

### 4. Conclusion and Recommendation

The results of the assessment show that the level of adaptive capacity of fishermen household in Muncar District is categorized into the medium level. This result does not only come from the fishermen households but also influenced by the role of fishermen groups and local government units although the

local government unit (LGU) has been providing training. Whereas, if the fishermen groups (KUBs) are not active encouraging their members to attend the training, it will affect the capacity of their members. Vice-versa, if KUBs actively carrying out activities but the LGU does not support for example in terms of assistance provision, it will also affect the capacity of KUBs' members.

The recommendations for enhancing the fishermen household's adaptive capacity are divided into the theoretical and practical side. From the theoretical side, considering the fact that there is no study that specifically discusses fishermen adaptive capacity especially in Indonesia, the framework which is presented in this study can be used as a reference in assessing the adaptive capacity of the fishermen household in other regions. Each criterion and indicators which had been formulated by compilation and modification in this study can be used to assess the adaptive capacity in terms of marine fisheries. The adaptive capacity becomes important to assess because each indicator can be considered in formulating the adaptation options.

From the practical side, it is necessary to formulate the adaptation options. The adaptation options should be based on the circumstance of each criterion in the adaptive capacity assessment. In addition, it is also necessary the synergy of fishermen households, fishermen groups, and local government participation to implement those adaptation options. Considering the result that most of the households have low and very low adaptive capacity in economic resources criteria, it is necessary to develop the livelihood diversification. By having the alternative livelihood, the fishermen still are able to maintain the stability of their financial condition when they cannot get fish. For increasing fishermen household's adaptive capacity in the social capital criteria, the KUBs needs to actively hold the activities such as training and discussion in order to empower the member socially and economically. Whereas, in the information, technology, and infrastructure criteria, it is necessary to introduce new vessel which has a larger volume (more than 5 gross tonnages) and to improve the fishermen's skill to use. Thus, the fishermen can sail further and get more fish to sell. In addition, the information system also needs to be developed so that each fisherman obtains the information about fishing ground and weather.

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