https://doi.org/10.1051/bioconf/202517104002

Key variables for sustainable management of The Belida (*Chitala lopis*) Fishery at inland waters in Kapuas Hulu Regency

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Abstract. Sustainable management of the Belida (*Chitala lopis*) fishery at inland waters in Kapuas Hulu Regency is a process of improving environmental approvals. In order to realize fisheries sustainable management, it is important to map the position (relationship) between the variables in it and their position based on the relationships formed. In order to support business licensing in Indonesia. The research method used was the foresight analysis method, with the type of data obtained through FGD as a questionnaire-filling technique. The respondents in the research were 11 experts. MICMAC and prospective analysis are the software and methodology utilized in this study. The findings of the analysis demonstrate that local knowledge, fishery policy, captured fisheries production, fish price, market demand, water quality, and fishery conservation area are the key variables in the sustainable management of the belida fishery at inland waters in Kapuas Hulu Regency.

1 Introduction

Kapuas Hulu Regency is one of the administrative regions in West Kalimantan Province that has a large potential for inland waters (Perairan Umum Daratan/PUD), including rivers, lakes, and swamps reaching two million hectares [1, 2]. One of the largest rivers in this region is the Kapuas River with a length of about 1,080 km and is the longest river in Indonesia [3, 4]. The PUD area in West Kalimantan is estimated to be inhabited by about 300 species of fish, of which about 100 dominant fish species have important economic value, such as Belida, Gabus, Sepat, Jelawat, Kelabau, Patin, Betutu, Papuyu, Baung, Catfish, and others

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Freshwater fish production in the inland waters of West Kalimantan Province mostly comes from PUDs in the Kapuas Hulu Regency [5, 6].

In general, the four species of belida fish in Indonesia are *Chitala borneensis*, *Chitala hypselonotusc*, *Chitala lopis*, and *Notopterus notopterus.* Based on research conducted in Java, the belida fish species *Chitala lopis* is considered extinct because it has never been found again [7–10]. Habitat degradation, followed by a decrease in the quality and quantity of river, swamp, and lake habitats, is thought to be the cause of the extinction of this species in Java. If fisheries management actions are not carried out properly and correctly, this species of Belida fish will become extinct in Kalimantan Island, especially in Kapuas Hulu Regency [11, 12]. The status and potential of fisheries resources become complex after human intervention due to high demand, followed by the exploration and exploitation of fisheries resources. Uncontrolled fisheries resource management conditions, exploration and exploitation activities can deplete fisheries resources.

Belida fish (*Chitala lopis*) is an important native or endemic fish species with high economic value among the various freshwater fish species that inhabit public waters in the Kapuas Hulu Regency. Belida fish of certain sizes are consumed directly as food and are mostly made into processed forms such as dry and wet crackers. Belida fish has a distinctive texture and flavor, making it and its processed products popular and sought after by the community. However, the availability of belida fish in Kapuas Hulu Regency has started to decrease and continues to decline. However, the decline is not the same as that in Java and Sumatra, as the PUD potential in Kapuas Hulu is still quite extensive. In addition, much local knowledge is used as social capital in fisheries management, and Kapuas Hulu Regency has been classified as a conservation regency. However, the management of Belida fish from PUD in the Kapuas Hulu Regency requires serious attention to prevent extinction.

The exploration of belida fish in the PUD of the Kapuas Hulu Regency has been carried out for a long time by local communities and fishermen. However, according to the Minister of Environment and Forestry Regulation No. P.106/MenLHK/Setjen/Kum.1/12/2018, belida fish have been classified as protected fish species. In fact, communities continue to catch this fish because it has a high selling price and buyer interest [13]. The high demand could lead to overexploitation of belida fish. A further impact is the reduction of fish populations in nature, which is characterized by the rarity of Belida fish species found or fish caught dominated by small fish [14, 15]. The catch is decreasing day by day, while the frequency of fishing is increasing. Various extractive activities that cause land conversion and diversion of water resources for plantations, agriculture, settlements, and mining are thought to have affected the sustainability of Belida fish resources in the region. In addition, the decline in Belida fish production is also influenced by the high demand for processed products made from Belida fish, both at the local and inter-regency levels in West Kalimantan.

The fact that small-sized fish dominate the catches of local fishers indicates that overfishing has occurred. This occurs because young fish in the water or the fishing area are caught before reaching adult size. Previously, intensive fishing was conducted on adult fish. Over time, the number of Belida fish will decrease so that, at some point, there will not be sufficient broodstock to maintain the population. However, there is currently no information on the stock of Belida fish in the inland waters of the Kapuas Hulu Regency. This information is needed to estimate the stock's sustainable potential, distribution, growth patterns, when and where it spawns, when it can be caught, and how much should be caught [11].

Sustainable Belida fisheries management in PUD is expected to realize the goal of efficient and highly competitive fisheries development to benefit all business actors and contribute to high economic growth on an ongoing basis. Fisheries management ensures the sustainability of fisheries resources and ecosystems. Fisheries are essentially included in the three primary facets of sustainable development, which are ecological, economic, and social. For instance, using fishing gear that is not environmentally friendly will decrease fish populations and possibly lead to the extinction of some fish species if ecological sustainability is not maintained. This can cause fisheries' economic activities to stop and affect the social and economic well-being of those who engage in fisheries. For instance, low fish prices that do not correspond with operating expenses would result in widespread exploitation to pay production costs, harming fisheries' natural vitality, and compromising economic sustainability. Similarly, using fisheries and engaging in economic activity can result several social disputes within the community if the social lives of those involved in the industry are not sustainable. Thus, at an early stage, efforts are needed to identify important variables that support sustainable Belida fisheries management in Kapuas Hulu Regency.

2 Methods

2.1 The focus group discussion

The variables for sustainable management of the Belida fishery at inland waters in Kapuas Hulu Regency were analyzed by dealing with 17 variables. This study employs the prospective structural paradigm methodology to investigate the structure, dynamics, and interrelationship network among the most critical variables for the sustainable management of Belida fish in the inland waters of Kapuas Hulu Regency. Data were gathered through the utilization of Focus Group Discussions (FGD) methodology for identifying the influential and critical variables in the development of the area and seminars during the data entry process within the software utilized for data analysis. The discussion execution utilizing the World Café methodology aims to foster interaction, facilitate knowledge exchange, and promote the transfer of experiences among participants. The FGD participants totaled 11 people representing stakeholders.

2.2 Micmac analysis

Data analysis utilizing the Micmac Method involves applying Cross Impact Matrix Multiplication for classification purposes. Micmac is a software application developed by the Institut d'Innovation Informatique pour l'Entreprise, designed to advance the structural analysis methodology from a qualitative framework to a quantitative one. In its operations, Micmac utilizes the properties of matrices. The aim of Micmac is to identify and analyze the principal variables within a system. Compared to other structural methodologies, the advantage of Micmac lies in its capacity to facilitate the categorization and establishment of the hierarchy of strategic variables within a system and elucidate their interrelationships and mutual influences. This feature is highly beneficial in the policy-making process, as it effectively directs the focus of the policy. This is particularly important given that an inappropriate policy focus frequently results in the consideration of irrelevant variables, ultimately leading to failure.

The elucidations offered by the Micmac analysis will foster enhanced confidence and trust regarding the issues presented while also articulating various underlying assumptions. The implementation of the Micmac method comprises several distinct stages, specifically: (1) the definition of the problem and the identification of both internal and external variables; (2) the evaluation of the interrelationships among these variables based on their levels of influence and dependence, which are quantified using a rating scale ranging from 0 (none) to 1 (weak), 2 (moderate), 3 (strong), and P (potential). The assessment outcomes will categorize the intensity of influence among the variables into three distinct groups: direct influence, indirect effect, and prospective influence. A direct effect transpires when variable A exerts an influence on variable B. Conversely, an indirect effect arises when variable A impacts variable B, which in turn influences variable C, thereby resulting in C being indirectly affected by A. A potential effect arises when variable A is posited to influence variable B; conversely, no direct impact is observed when a variable does not exert any influence on other variables; (3) Analysing the magnitude of influence and interdependence among the variables as determined by their positioning on the quadrant map of influence and dependence (Fig 1. The Micmac analysis.)

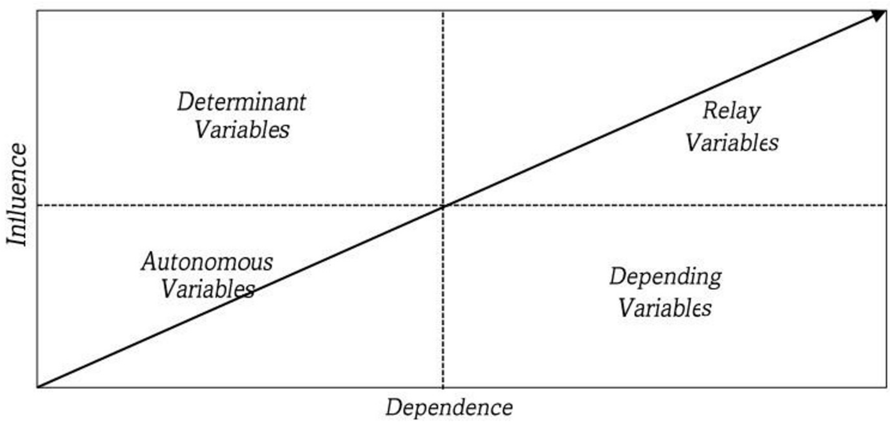

Fig. 1. The Micmac analysis

Fig 1 facilitates the examination of the influence and interdependence of system variables, categorizing them into four distinct typologies: determinant variables, relay variables, autonomous variables, and output variables. The determinant variable is a highly influential and exhibits a degree of dependence on other variables. These variables are regarded as inputs and significantly influence the system's mobility. The determinant variable is of paramount significance and necessitates the utmost attention from policymakers, as it substantially influences other variables. Relay variables (stake variables) are also termed key variables. The relay variable exerts significant influence while exhibiting high dependence on other variables. These variables exhibit the least stability, as any perturbation affecting them can propagate throughout the entire system. The relay variable is alternatively referred to as the instability factor due to its "boomerang effect" on the system, signifying that interventions concerning this variable will influence the trajectory of system dynamics. Autonomous variables exert a minimal influence and minor dependence on other variables. This variable exhibits a limited capacity to induce alterations within the system, indicative of trend inertia. Autonomous variables are alternatively referred to as excluded variables. Autonomous variables are divided into disconnected variables and secondary levers. Discontinuous variables and their evolution are situated near the origin; consequently, they may be excluded from the system's dynamics. Although the secondary lever variables are positioned above the diagonal line, specific actions can enhance the robustness of the system. The output variable is commonly referred to as the dependent variable. The output variable delineates the effects arising from other variables, particularly the determinant and relay variables. This variable is situated in the southeastern quadrant of the map. The positioning of the output variable indicates that it exhibits minimal influence while demonstrating a high degree of dependence, rendering it particularly sensitive to the influencing factors. This variable serves as a descriptive indicator of the system's evolution. These variables are subsequently aggregated within the Micmac software utilizing the Matrix of Direct Influence (MDI) to ascertain each variable's influence. The MDI is the foundational matrix for compiling the Matrix of Indirect Influence (MII), which delineates the magnitude of the indirect influence exerted by various variables. Additionally, it underpins the Matrix of Potential Direct Influence (MPDI), which forecasts the intensity of influence these variables may exert should the system undergo alterations at a subsequent point.

3 Results and discussion

The outcomes of this study are predominantly contingent upon the precision of the sources in delineating the variables believed to influence the sustainable management of the Belida fishery in the inland waters of the Kapuas Hulu Regency. To accomplish this, in the early stages of FGD, participants were given an orientation by experts on the sustainable management of the Belida fishery. The expert is selected by the basis of their capability and knowledge of the Belida fisheries in Kapuas Hulu, with qualifications had been engaged in this field for 10 years. Subsequently, the variables were compiled, drawing upon the participants' comprehension, knowledge, and experiences. The outcomes of the discussion revealed fifteen variables deemed influential in the sustainable administration of the belida fishery within the inland waters of the Kapuas Hulu Regency. These essential variables are categorized into three clusters of factors, as shown in Fig 2. These variables were subsequently aggregated within the Micmac software utilizing the Matrix of Direct Influence (MDI) to ascertain each variable's influence. The MDI is the foundational matrix for compiling the Matrix of Indirect Influence (MII), which delineates the magnitude of the indirect influence exerted by various variables. Additionally, it underpins the Matrix of Potential Direct Influence (MPDI), which forecasts the intensity of influence these variables may exert should the system undergo alterations at a subsequent point. A compilation of variables about the sustainable administration of the Belida fishery is presented in the Table 1.

Table 1. Tabel list of variables for sustainable management of the Belida fishery at inland waters in Kapuas Hulu Regency

No	Long label	Short label	Theme
1	Fish Price	Price	Economy
2	Captured fisheries production	Production	Economy
3	Processing of fishery products	Industry	Economy
4	Market demand	Market	Economy
5	Local government revenue	PAD	Economy
6	Fishing cost	Cost	Economy
7	Fishermen's income	Revenue	Economy
8	Number of fishing boats	Boat	Regulation
9	Government support	Support	Regulation
10	Fishery policy	Policy	Regulation
11	Fishery conservation area	Conservation	Regulation
12	Number of fishermen	Fishermen	Social
13	Local wisdom	Wisdom	Social
14	Education and skills of fishermen	Skill	Social
15	Quality of inland waters	PUD	Ecology
16	Fish stock condition in PUDs	Stock	Ecology
17	Climate changes	Climate	Ecology

The MICMAC analysis identified four main driven variables that greatly affect Belida's sustainable management. As shown in the figure map of direct influence, there are local wisdom, fishery policy, captured fisheries production, fish price, market demand, quality of inland waters, and fishery conservation area. These seven driven variables directly influence three relay variables in the relay quadrant (education and skill of fisherman, number of fishing boats, and fishing cost). Collaboration between the driven and relay variables influenced the dependent variables. There are five dependent variables: fish stock condition in PUDs, processing of fishery products, number of fishermen and fishermen's income, and local government revenue. These variables are shown in Fig 2.

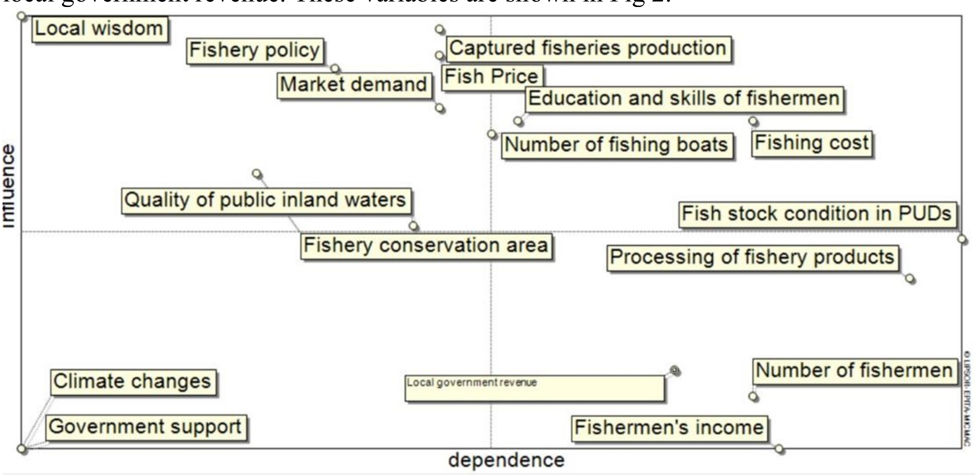

Fig. 2. The Micmac sustainable management of the Belida fishery at inland waters in Kapuas Hulu Regency

As a constellation, we can say that the drive, especially regulation, greatly influenced the sustainable management of the Belida fishery at inland waters in Kapuas Hulu Regency. In addition, the most influential variable is the local wisdom, fishery policy, market demand, captured fisheries production, fish price, water quality dan fishery conservation area. All of these variables occupied the position in quadrant one as driven variables status. Furthermore, in the upper right quadrant, you can see several variables that function as connecting variables or relay variables. Variable education and skills of fisherman, number of fishing boats, fishing cost, fish stocks condition in PUDs all function as relay variables that link the actions of the driven variables before impacting the set of dependent variables in the lower right quadrant. In the lower right quadrant, there are three variables that are affected, namely fisherman income, number of fisherman and local government income. Finally, in the lower left quadrant, two autonomous variables were found, namely government support and climate changes.

4 Conclusions

This research concludes that by the prospective analysis and MICMAC software, there are seven main driven key variables. The key variables for sustainable management of the Belida fishery at inland waters in Kapuas Hulu Regency are local wisdom, fishery policy, captured fisheries production, fish price, market demand, quality of inland waters, and fishery conservation area. The most very high driven power is indicated in the local wisdom. The key to success in applied sustainable management of the Belida fishery is regulation. So, strong and clear regulations made the sustainable management of the Belida fishery process clear.

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