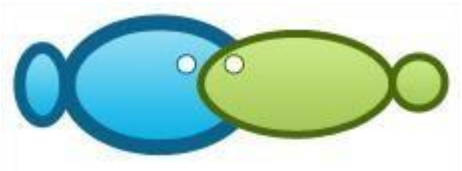

Conceptual model of integrated capture fisheries management on conservation area (WKPPT2) in Batang Bungo River, Bungo Regency, Jambi Province, Indonesia

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Abstract. A conceptual model is the limitation of the variables or concepts that need to be measured, and the management of capture fisheries on conservation area in Batang Bungo River is arranged into four stages of soft system methodology (SSM). The first and second stages of conceiving the rich pictures. The third stage was a root definition and the fourth created a conceptual model. The aims of the study are to create a conceptual model on conservation area management in Batang Bungo River, Bungo Regency, Jambi Province. The collection of data was conducted from September to November 2021 by using questionnaires, interviews, and focus group discussions. Then, data analysis used SSM. Finally, the results of the study showed that the conceptual model of conservation area management consists of six concepts, namely improving the quality of human resources, training on the product's cultivation, government's aid, making zonation, data establishing on fishing gear and institutional rules.
Key Words: human resources, soft system methodology, zonation.

Introduction. Batang Bungo River is one of the main rivers in Bungo Regency, Jambi Province with a length of ± 50 km. Budiyono (2011) stated the types of fish found in the Batang Bungo River were 25 species of freshwater fish from 16 genera and 9 families. Furthermore, Syaputra et al (2017) found that there are 156 individuals at the same location, consisting of 16 species representing 5 orders, 9 families and 15 genera. Along the Batang Bungo River, there are conservation areas established, known as "lubuk larangan" areas. The conservation areas on the Batang Bungo River were formed in 2013 with a total of 5 "lubuk larangan" (Bungo Regency Livestock and Fishery Service Unit 2018). At the time of this study (2021), the number of "lubuk larangan" areas along the Batang Bungo River increased to 33 and 1 reservation area. With an increase in the number of "lubuk larangan" areas, the impact felt by fishermen along the Batang Bungo River is the decrease in catches, fishing areas are getting smaller and fishing locations are getting farther away. Hilborn et al (2004) stated that an area of water conservation is one of the fisheries management tools which still arises pro and cons, specifically in the fishery significance. Therefore, a conceptual management model is needed to have an ecological balance. Checkland (1999) stated that the modeling tool used to easily understand the problems is called as soft system methodology (SSM). The conceptual model of conservation area management alongside Batang Bungo River is a system that involves various actors in its management to create sustainability for the fishery management system.

Sustainability of fisheries is a challenge, because fishery products are the needs of current and future generations, and the level of utilization will continue to increase in line with the level of local and global consumption needs. In addition, the stock of fish resources in several locations is increasingly limited even though fish resources are renewable. The inequality and unsustainability of resource use can occur if their

utilization exceeds capacity or because fishery activities only prioritize one aspect and ignore other aspects. Thus, the sustainability of capture fisheries must be studied comprehensively, covering various aspects. These aspects include ecological, technological, economic, social, ethical, institutional, and legal aspects (Alder et al 2000). Fishery management can be done with a comprehensive systems approach. System analysis can be defined as the decomposition of a complete system into its component parts with the aim of identifying and evaluating problems, opportunities, obstacles that occur and the expected needs so that improvements can be proposed. Furthermore, the analysis stage is vital and errors at this stage will lead to errors in the next stage. At the analysis stage, there are some steps that must be taken: identifying the problem (identify), understanding the work of the existing system (understand), analyzing (analyzing), and reporting (report) (Jogiyanto 2005).

This study aims to create a conceptual model for conservation area management alongside Batang Bungo River, Bungo Regency, Jambi Province. The fishery management involves many aspects, which relate to ecological, economic, social, technological, ethical, and institutional aspects. One of the management model approaches that can be used is soft system methodology (SSM). In addition, SSM as an approach is expected to be able to overcome any complex problems. Then, the approach is considered an effective method for studying every organized human activity in achieving certain goals (Ikhsan et al 2017).

Material and Method. Research method used was the survey method. The research was conducted from September to November 2021, in three conservation stations in Batang Bungo area namely: The first station was the conservation area located in Laman Panjang Village, Bathin III District. The second station was in Lubuk Manic Rantau Pandan Reserve utilization area, Rantau Pandan District. Then, the third station was in Tebat Village, downstream of the river, Muko-Muko Bathin VII District. The distance from the first station to the second station is ± 11 km and the distance from the second station to the third station is ± 9 km. The sampling technique used was purposive sampling by using questionnaires, interviews, and focus group discussions (FGD). Questionnaires and interviews were given to 120 local fishermen that came from three different areas, namely Laman Panjang Village (40 fishermen), Tebat (40 fishermen), and Rantau Pandan (40 fishermen). Meanwhile, FGD was conducted with some local public figures, as well as the fisheries ministry representative and customary institutions of Bungo regency. At the end, data which are taken from interviews and FGD will be the conceptual data for the conservation area and related authorities. The research location on the Batang Bungo River is depicted in Figure 1.

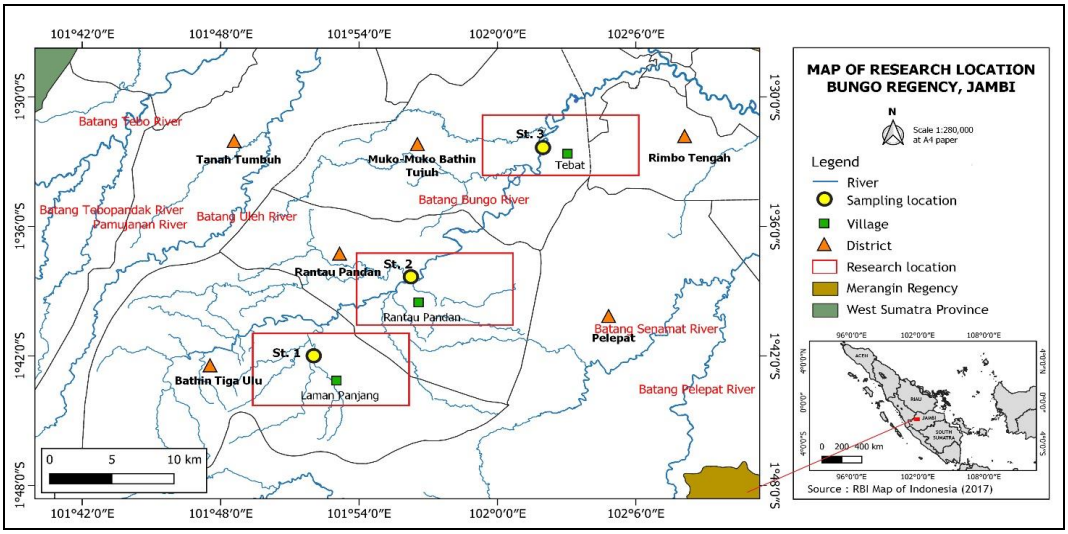

Figure 1. The research location (the Batang Bungo River, Jambi, Indonesia) (map generated using QGIS 3.16.11 Hannover).

Data analysis. The analysis data of the research used the soft system methodology (SSM) approach. According to Checkland and Poulter (2006), SSM could be carried out through seven stages. However, this study only used four stages of the SSM approach, carried out to produce a conceptual model. Moreover, the choice of four stages approach in the study it is suited to the purpose of the study, that only creates a conceptual model. The details of each stage are: the first and second stage, understanding the problems, the results of which are described with a rich picture; the third stage, establishing root definitions to address the problems that have been formulated; the fourth was to create a conceptual model based on root definitions. In addition, Rahmah et al (2017) also defined that soft system methodology (SSM) approach can produce a conceptual model that can be used as a reference in improving the existing system.

Result and Discussion

The revelation of problem situations. Bungo Regency is geographically located in a strategic area. This includes the national route for the central region of Sumatra, and it is rich in natural resources. Bungo Regency has an area of 6,907 ha of public waters consisting of rivers, swamps, lakes, dams, and other water bodies. Some of the main rivers in Bongo Regency include Batang Jujuhan River with a length of ± 153 km, Batang Senamat River with a length of ± 90 km, Batang Pelepat River with a length of ± 80 km, Batang Tebo River with a length of ± 80 km, and Batang Bungo River with a length of ± 50 km.

Batang Bungo River, it is used by the community for: discharge of used water, plantations, agriculture, fishing, cultivation, mining, conservation areas and reservation areas. The existence from the Ministry of Fisheries of Regulation No. 09/2020 (KKP 2020) concerning the Indonesian state fishery management area of inland waters (WPP PD RI) has caused river waters to be a serious concern. Therefore, it is very important to formulate a management model. Sustainable fisheries management in Batang Bungo River water conservation area obtained multidimensional scaling (MDS) analysis results from sensitive dimension attributes, that show the potential problems of the area in the future. Some of the sensitive attributes in the MDS analysis that are of serious concern in fisheries management in Batang Bungo River are the ecological dimension (catch size and the size of the fish caught), the economic dimension (fishing in the gross domestic product-GDP, government subsidies and profit/price), the technological dimension (selectivity), fishing gear and handling (processing before sale), social dimension (conflict of interest, education level and number of fishing households), code of ethics dimension (discharges and fishery regulations) and institutional dimension (regulative and organizational).

Water quality in Batang Bungo River is affected due to illegal mining of sand and gold in several places. The problem manifests by cloudy water and siltation at the bottom of the river. According to Redondo-Vega et al (2017), the extraction of mineral resources by surface mining resulted in damage to the topography, and this change cannot be reversed to its original state. Alber (2002) stated that changes in freshwater characteristics as humans continue to affect the quantity, timing, and quality of freshwater input into estuaries, it becomes increasingly common for policies to be concerned about the establishment of freshwater flow criteria, that will serve to conserve and protect ecosystems. Some changes in freshwater flow affect estuaries, so we need a conceptual model that can explore the role of scientists, residents, politicians, and managers in managing or handling freshwater flows to estuaries and use models to explore and maintain sustainability of freshwater ecosystems.

Fishermen income does not depend entirely on fish catch, because most anglers alongside the river are part-time fishermen. The income from fishing is only enough to meet basic needs. In addition, government assistance/subsidy is also minimal, the government aids only once in a year, and even then, not all groups get it, and a lot of assistance goes to the cultivation sector. Assistance is not the main thing in increasing income, but how the community or fishery households (RTP) are able to be creative with processing the fishery products they make, so it can increase the selling price of the

product. Fisheries in the GDP represent a small sector, so the attention of local governments has not been fully directed to the fishery sector. Illegal fishing activities often happen alongside Batang Bungo River, in the form of ecologically unfriendly fishing methods such as using destructive techniques, like electric and poison fishing.

The organizational structure of Lubuk Larangan management institutions should receive attention in increasing management capacity. In addition, low levels of education and conflicts of interest in the use of river bodies also occur when each hamlet determines the Lubuk prohibition as a right managed by the hamlet to ensure the sustainability of fish resources within a certain period. On the other hand, when there is damage to the upstream area, the downstream area does not escape the impact. More clearly, the problems of the conservation area for capture fisheries management (WKPPT2) alongside Batang Bungo River can be seen in (Table 1).

Table 1

Problems of integrated capture fisheries management conservation areas along the Batang Bungo River

No	*Aspects of the study*	*Problems*
1	Ecology	Catch suitability (the number of fish caught not suitable for catching according to gonad maturity level) Size of fish caught
2	Economy	Fisheries in GDP Government subsidies Profit/price
3	Social	Conflict of interest Level of education Number of fishing households
4	Technology	Selectivity of fishing gear Handling/processing before sale
5	Code of ethics	Number of fish wasted (discards) Fishing regulations
6	Institutional	Regulatory Organization

Figure 2 shows the picture based on understanding the problem situation at the first stage of SSM. The rich picture made in the form of an image showing the structure and process of activities in the integrated capture fisheries management conservation area (WKPPT2) alongside Batang Bungo River. Gigentika (2017) stated that the structure in term is the causal effect structure and communication patterns for each stakeholder, both formally and informally. In fact, the process which is intended is the monitoring and controlling process. In addition, the rich picture will also show the problems that exist in each structure and process of its activities. The rich picture shows problems that become priority issues to be resolved or given efforts to solve them through the next SSM stage.

The existence of a rich picture can facilitate the creation of a conceptual model, that can be used later to examine how a detailed system solves problems (Lewis 1992; Bergvall-Kåreborn 2002). Although the strengths of the connected stakeholders may vary from place to place, the problem is still identifiable. Like the conceptual model described by Alber (2002), that the involvement of politicians directs managers to protect estuary resources, and they respond by setting freshwater flow guidelines directed at meeting key objectives. Then experience flow support states such as: Texas, Florida, and California. This generalization provides examples of resource-based, inflow-based, and condition-based estuarine inflow management approaches.

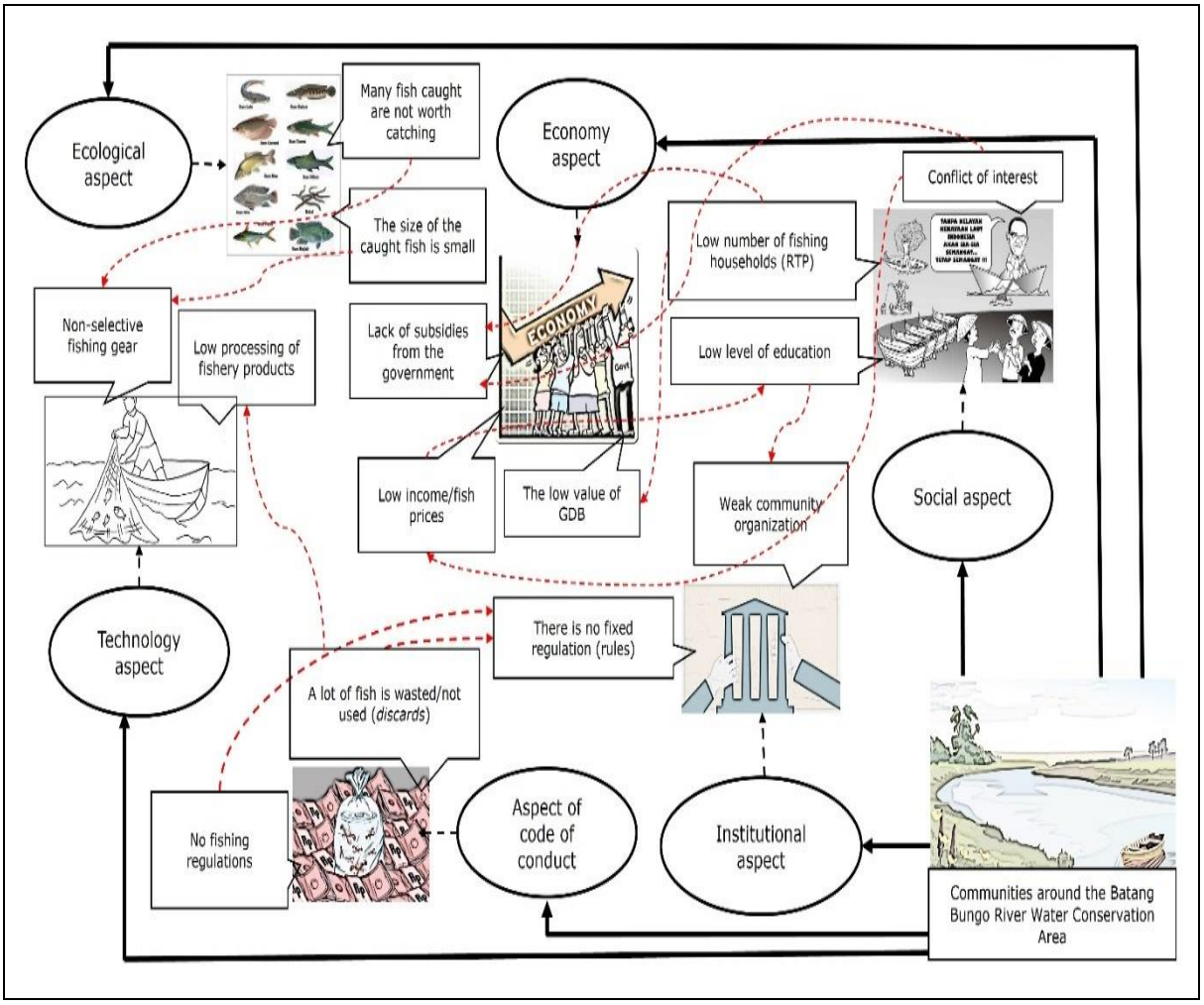

Figure 2. Rich picture of the integrated capture fisheries management conservation area (WKPPT2) alongside Batang Bungo River.

Root definitions (RDs). The stage of compiling the problem definition and conceptual modeling is part of the systems thinking stage about the real world in the soft system methodology (SSM) approach. The stage of compiling the problem definition produces root definitions (RDs) which are a way of illustrating the system to assist the system modeling process at the conceptual modeling stage. The RDs that have been produced are: definition 1, improving the quality of human resources by providing higher education for the younger generation; definition 2, training in processing fishery products to increase value (selling price) of fishery products; definition 3, increase subsidies for fishermen to help fishermen's welfare standard of living (RTP); definition 4, making rules for conservation areas and integrated capture fisheries management, so as to minimize conflicts of interest; definition 5, making rules on allowed fishing gear and fish size per suitable species to catch; definition 6, increasing the role of institutions by establishing an organization to monitor the environment and aquatic resources. Root definitions (RDs) must be used as the basis for conceptual modeling, so these RDs need to be tested and refined with the CATWOE analysis tool (customers, actors, transformation, worldview, owners, and environmental constraints).

This CATWOE tool is a reminder tool (mnemonic) so that the RDs made can describe a system of relevant human activities. Then it is necessary to continue with the question of the performance measurement criteria for the operation of the activity system that has this purpose, generally 3E criteria are used, efficacy, effectiveness, and efficiency. Based on the CATWOE analysis and the 3E criteria, RDs are obtained in describing the system. The checklist and three criteria are how this transformation process should be carried out. RDs analyzed are shown in Table 2.

Table 2

CATWOE and 3E. The stage of compiling the problems of Batang Bungo River

	Root definitions (RDs)					
CATWOE and 3E	Improving the quality of human resources with higher education for the younger generation (RDs 1)	Training on processing fishery products to increase value (selling price) of fishery products (RDs 2)	Increase subsidy assistance for fishermen to help fishermen welfare standard (RDs 3)	Rules for conservation areas and integrated capture fisheries management, to reduce conflicts of interest (RDs 4)	Rules about the allowed fishing gear and the size of fish per species that is suitable for catching (RDs 5)	Increasing the role of institutions by forming organizations to monitor the environment and aquatic resources (RDs 6)
Customers	Local and hamlet government	Local government, hamlets, and business actors	Central, regional and hamlet government	Central, regional and hamlet government	Central, regional and hamlet government	Central, regional and hamlet government
Actors	Central, regional and hamlet government	Entrepreneurs and fishermen	Central, regional and hamlet government	Central, regional and hamlet government	Central, regional and hamlet government	Central, regional and hamlet government
Transformation	Improving the quality of human resources (education scholarships)	There is a diversification of fishery products	There are subsidies for RTPs equally	There are regional zoning rules and maps	Availability of data on fishing gear and size of fish suitable for catching	Increased interaction and cooperation
Worldview	Government fully supports the improvement of human resources with educational scholarships for fishing households	Fishermen make fishery products according to market needs	Subsidy assistance continues every year	Involving academics in making regional zoning rules and maps	Involving academics in recording fishing gear and fish size suitable for catching	Establishment of non-governmental fisheries organizations and independent organizations
Owners	Central, regional and hamlet government	Central, regional and hamlet government	Central, regional and hamlet government	Central, regional and hamlet government	Central, regional and hamlet government	Central, regional and hamlet government
Environment	Support from ministry, Jambi Governor, Bungo Regent, budget availability and resources	Support from ministry, Jambi Governor, Bungo Regent, budget availability and resources	Support from ministry, Jambi Governor, Bungo Regent, budget availability and resources	Support from ministry, Jambi Governor, Bungo Regent, budget availability and resources	Support from ministry, Jambi Governor, Bungo Regent, budget availability and resources	Support from ministry, Jambi Governor, Bungo Regent, budget availability and resources
Efficacy (E1)	Improved quality of human resources	Fishermen's income increases	Subsidies distributed well and evenly	Availability of regional zoning rules and maps	Valid data on fishing gear and fish size suitable for catching	Optimization of institutions and organizations that have been formed
Efficiency (E2)	Using minimum human	Using minimum human	Using minimum human	Using minimum human	Using minimum human	Using minimum human

	resources, financial resources, and time	resources, financial resources, and time	resources, financial resources, and time	resources, financial resources, and time	resources, financial resources, and time	resources, financial resources, and time
Effectiveness (E3)	The achievement of improving the quality of human resources	The achievement of fishermen's income increases	Increased fisheries subsidies	Achieving regional zoning rules and maps	Achieving valid data collection on fishing gear and fish size suitable for catching	Achievement of the optimization of institutions and organizations that have been formed

Conceptual models. Conceptual models can solve many obstacles of using bigger ecosystem model in strategy and especially for taking decision tactically to cultivate fisheries and conservation sources (Plagányi et al 2014). In the implementation of conceptual model for integrated fisheries and conservation, Garcia and Cochrane (2005) involved many challenges for the stakeholders. The policy makers need to: 1) Increase the fisheries governance, 2) identify the main operational purpose, 3) allocate the resources through a suitable right system, 4) identify the right set of stakeholders and overcome a complicated problem fairly, 5) maintain the fisheries production as well reduce the environment impact and lobbying the environment pollution and beach degradation.

The result of conceptual model cultivation based on RDs, are depicted from Figure 3 to Figure 8.

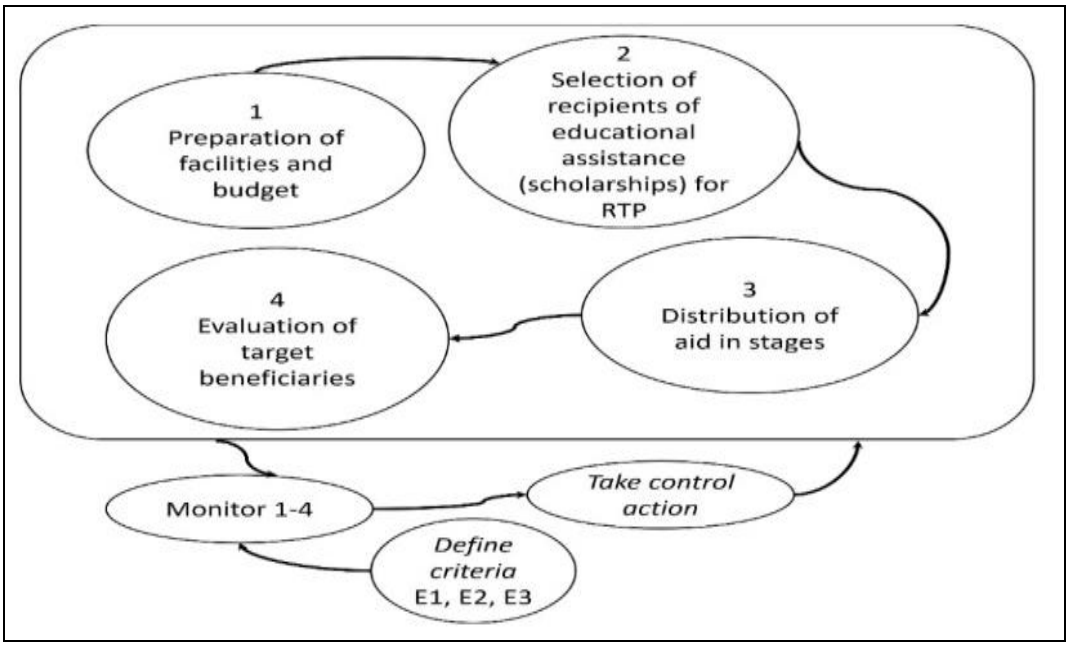

Figure 3. Conceptual model of HR Improvement.

Root definition 1 shown in Figure 3 is a human resource problem in the community in the conservation area along Batang Bungo River still related to the low quality of human resources or competences level of undergraduate degree (S1). Some of them only reached primary school until high school (senior high school and vocational school). The problem basically can be solved by providing educational scholarships. Furthermore, Arnawa et al (2017), stated that the problem of human resources and education level is a common problem both in society and in government, so it is very important in improving human resources and education to achieve a good governance system.

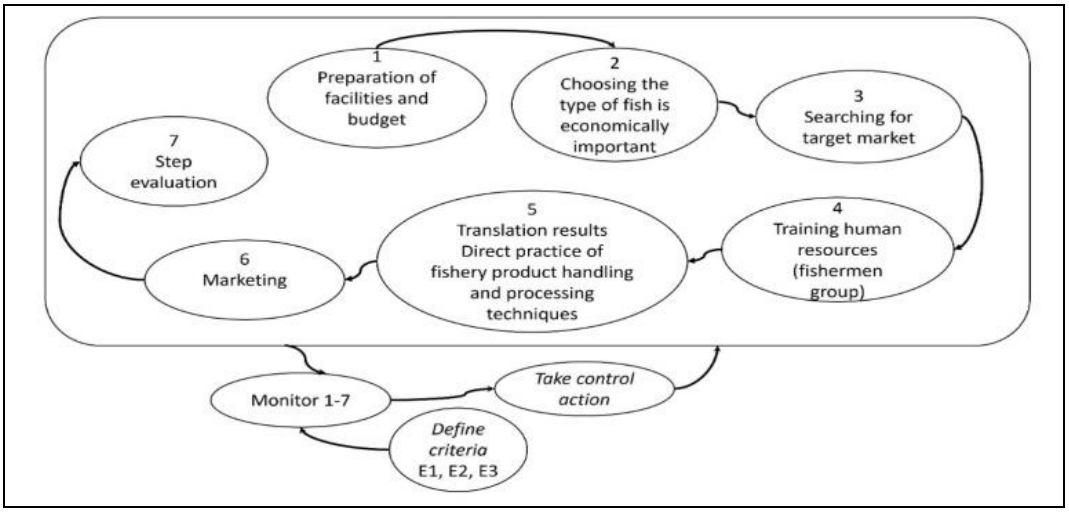

Figure 4. Conceptual model of fishery product processing training.

Root definition 2 shown in Figure 4 is the problem of the lack of training in processing fishery products to increase value (selling price) of fishery products in conservation area (WKPPT2) of Batang Bungo River. To overcome the economic threats in the fishery sector, there is a variety of fishery products to consider, like fermentation products, so that the development of local product diversification can be viewed as a strategic way to maintain the food security, especially related to promoting aspects, overcome the nutritious matter and empowerment of society, as well as the development of economic productivity. In downstream area, the management and productivity markets, automatically can stimulate the productivity of upstream area, which reflects from the fulfilling of food needs for the households, which reflects from the food security, either regarding quantity or quality, safety, and affordability. It will be running smoothly with the increase of human resources by continuous education of the youth, so that the young generation can understand how to cultivate the human resources wisely. Charles (2001) stated that the relationship between human system with the fishery activity has internal factors such as human resources between the fishermen community, the fishing technology, fishermen community structure and the households, as well as the pattern of fishing capture.

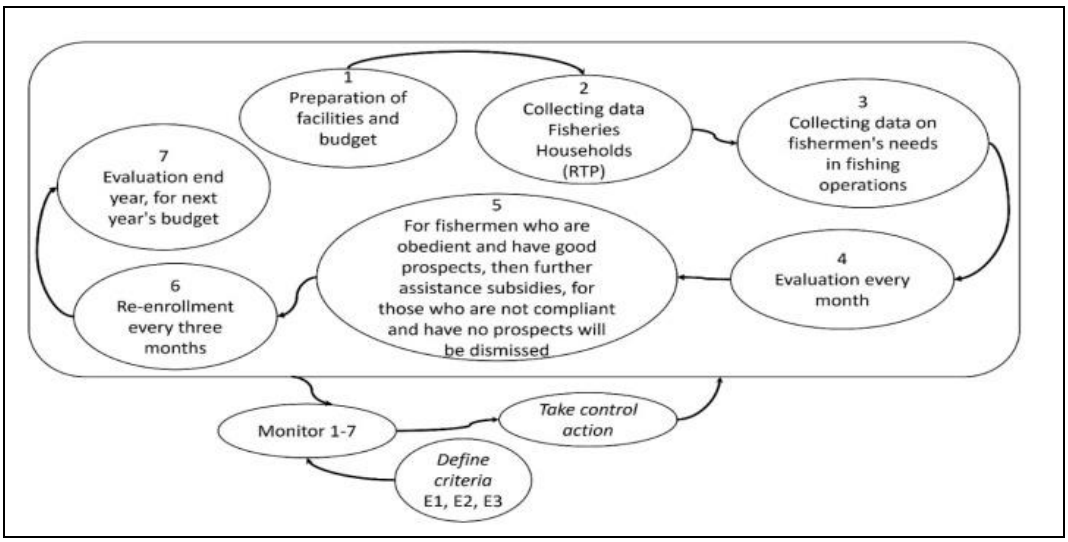

Figure 5. Conceptual model of government subsidy assistance.

Root definition 3 shown in Figure 5 is a problem regarding subsidized assistance for fishermen (RTP). To achieve prosperity, it is better to have subsidies for RTP evenly (Arnawa et al 2017). Putri et al (2021) explained that the impact of providing assistance for capture fisheries facilities has a positive impact on catch production, has a positive

impact on revenue and there is a significant influence on the income-productive business funds for fishermen. Then, it is also stated by Budianto et al (2017) that fishermen's perceptions of the fishing gear assistance program that have been provided by the government are right on target, beneficial to fishermen in need, and the attitude of government officials to provide any help was accepted nicely by fishermen. Besides that, any kind of help can also facilitate the fishermen in supporting their activity in "lubuk larangan" areas. Chen (2020) stated that the reconstruction of rapid growth of development can be focused on giving subsidy for even other kinds of disasters, like Covid-19, which had an impact on the economy of all sectors and all regions in Indonesia. This disaster was able to affect the economy and change people's lifestyles.

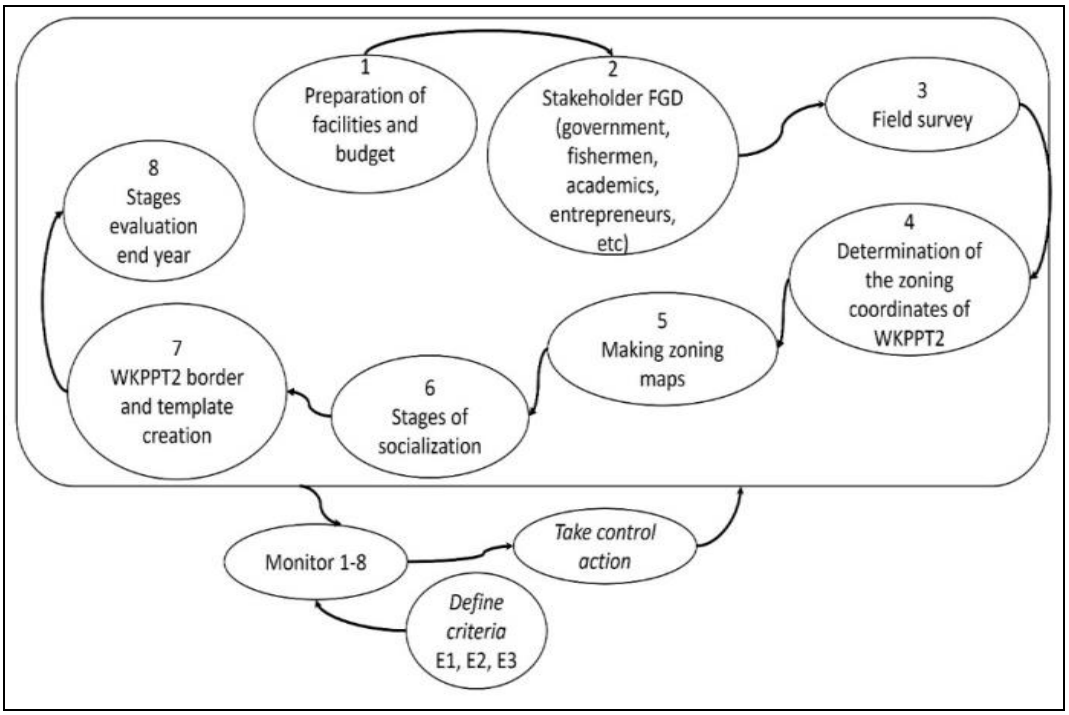

Figure 6. Conceptual model for making zoning map of conservation and management areas integrated capture fisheries (WKPPT2).

Root definition 4 shown in Figure 6 regards the problem of the rules of conservation area and integrated capture fisheries management, where there is a conflict of interest. It can be solved in by making rules of conservation area and the cultivation of integrated fisheries management (WKPTT2) in Batang Bungo River so that it can minimalize the conflict of interest. The board of central Atlantic Fisheries Management adopt the integrated ecosystem assessment (IEA) approach and applied the frame of structure for solving the problem of species, armada, habitat, and climate interaction as part of ecosystem for fishery management (Muffley et al 2021). In order to minimalize the conflict of interest and good cultivation it needs rule and zone mapping area (Bawole et al 2011). Jentoft (1989) stated that co-model management is needed for the government and society actively involved to design, implement, and carry on the rules related to fisheries.

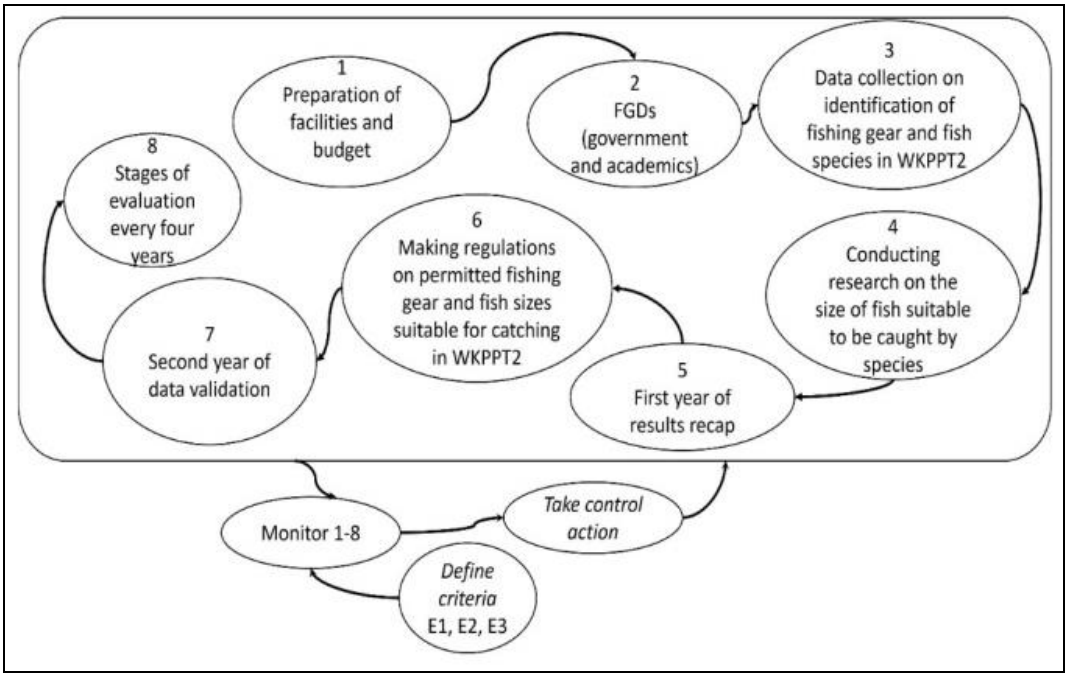

Figure 7. Conceptual model for collecting fishing equipment and fish sizes worth catching for integrated capture fisheries conservation and management area (WKPPT2).

Root definition 5 shown in Figure 7 is a matter of the rules regarding the allowed fishing gear and the size of fish per species that are suitable for catching, so it can help the society to understand that there will be punishment for the ignorance of the rules and make society aware on the rules. By systematic rules, they can facilitate the government in monitoring the activities from WKPPT2. The solution is the validity data of fishery gear and the size of fish caught in WKPPT2. The regulation and the rule of using gear is needed in order to achieve the cultivation of sustainability of fishery cultivation. The most common problem that often occurs in WKPPT2 of Batang Bungo River is the use of harmful tools such as electric equipment and poison used to kill the fish, and other illegal fishing activity in which all kinds of fishes are caught. Plagányi et al (2014) stated that ecologic approach is very important in making the simple rules based on the effort of fishing to modify recruitment from the bay area. It is also explained further that one way is identifying important species, then deciding how each of them will be protected. Generally, more complexity nevertheless will lead to bigger challenges, such as making model parameters, measure the uncertainty, and evaluate the suitable diagnostic of abstract resolution. As the result, it needs some modeled populations based on age, length, life cycle, and others.

The most realistic thing actually is having good understanding about the measure and distribution of their growth which relates to the management of biological varieity (Blanchard et al 2010, 2011). In addition, data of species which belong to WKPPT2 in Batang Bungo River, should be systematically recorded, along with the size of each species at which it can be caught. It is important for the controlling system regarding the sustainability of the river ecosystem.

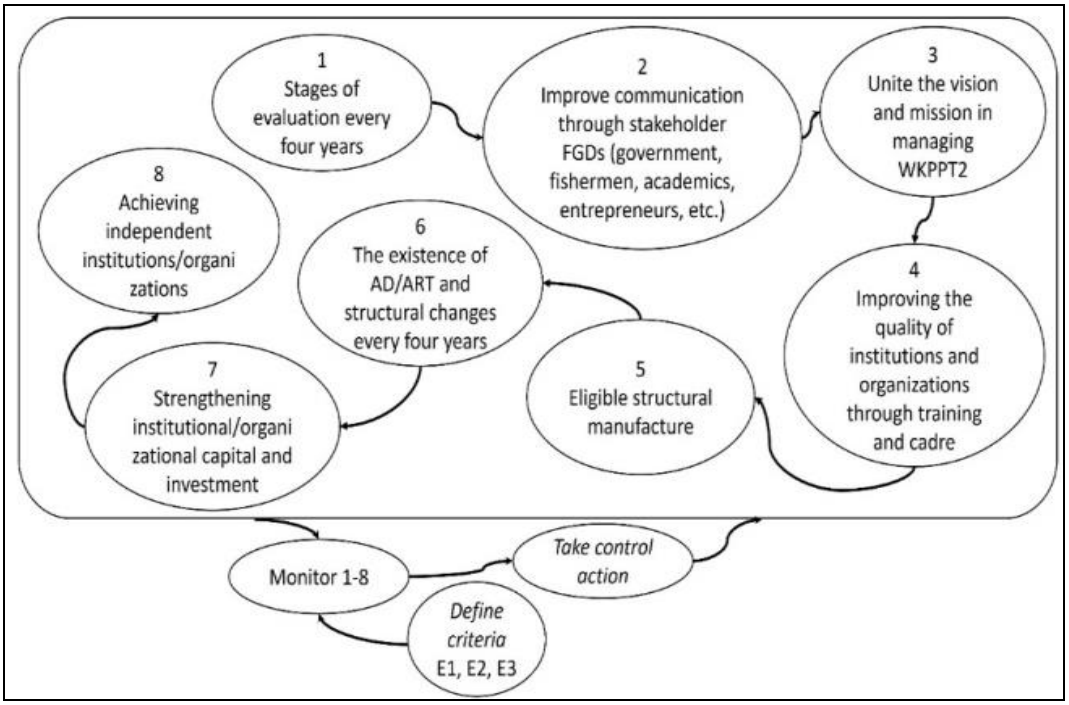

Figure 8. Conceptual model for institutional and organizational development in integrated capture fisheries conservation and management (WKPPT2).

Root definition 6 shown in Figure 8 is a problem regarding the absence of institutional and organizational roles to monitor the environment and resources in the waters of the Batang Bungo River. The solution is to increase interaction and cooperation in order to form non-governmental fisheries organizations and independent organizations. In order to supervise the environment and the aquatic resources the rule or mechanism which formally applies is needed. Jentoft (2004) and Charles (2001) stated that the institution is the key dimension in cultivating of fishery and institutional interaction which will impact the sustainability of the fishery. Challen (2000) and Makino and Matsuda (2005) stated that institution is characterized by the boundary of jurisdiction, arrangement, and organization.

The role of institution and local society participation is really important in cultivation of WKPPTT2 of Batang Bungo River since the involvement of society is really important to avoid the barriers and to run out of expectation, so that violations often occur in WKPPT2. Forsyth and Johnson (2014) stated that it really needs the institutional intervention in order to make any local policies to arrange exploitative behavior. Then, there are some institutions that are recommended to oversee fisheries in the future such as the Ministry of Maritime Affairs and Fisheries of the Republic of Indonesia, local government, and education sector.

The results of the evaluation of the integrated capture fisheries management conservation area (WKPPT2) alongside Batang Bungo River revealed problems in the aspects of human resources, lack of training in processing fishery products, low government subsidies, the absence of regulations for conservation areas and integrated capture fisheries management, and the absence of regulations regarding permitted fishing gear and size of fish per species suitable for catching and the absence of an institutional role.

Conclusions. The results of the evaluation of the integrated capture fisheries management conservation area (WKPPT2) in the Batang Bungo River show various problems which could be grouped into aspects of human resources, aspects of creativity, aspects of development, aspects of regulations and institutional aspects. Root definitions are set to overcome existing problems. Root definition 1, can be overcomed by improving the quality of human resources, such as providing educational scholarship assistance. Root definition 2, regarding lack of training in processing fishery products to increase the

value (selling price) of fishery products, can be solved through diversification of various fishery products. For root definition 3, regarding subsidized assistance for fishermen, to achieve welfare, it is better to have subsidies for fishermen households evenly distributed. For root definition 4, regarding the lack of rules in WKPPT2 which determines conflicts of interest, it is better to establish proper rules and zoning maps. For root definition 5, regarding permissible fishing gear and size of fish per species that are worth catching, the solution is to have valid data on fishing gear and size of fish worth catching in WKPPT2. For root definition 6, regarding the lack of institutional and organizational role to oversee the environment and aquatic resources, the solution is to increase interaction and cooperation so that fisheries self-help institutions and independent organizations are formed.

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