



## Strategic Model for Mangrove Forest Resource Management in Boalemo District, Gorontalo Province

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### ARTICLE INFO

#### Article history:

Received: 14 March 2024

Accepted: 19 June 2024

Published: 29 July 2024

#### Keywords:

Management, resources, mangrove forest, ISM

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### ABSTRACT



Mangrove forest destruction in Boalemo Regency has increased significantly over the past decade. The condition of mangrove forests has been degraded due to the pressure of population growth, especially in coastal areas. Damage to mangrove forest resources is certainly very dangerous to the ecosystem of fisheries resources, biodiversity and destroys the stability of coastal forests that support the protection of inland and rural agricultural crops. The purpose of this research is to design a model of sustainable mangrove forest resource management strategy in Boalemo District, Gorontalo Province, so that it can be applied as a policy in improving and optimizing mangrove forest resource management efforts in Gorontalo Province. The method used is Interpretive Structural Modeling (ISM). The results showed that there are thirteen sub-elements of program requirements needed to build the model, of the thirteen elements of program requirements there are no sub-elements that occupy quadrant I, in quadrant II there are two sub-elements and in quadrant III there are six sub-elements, in quadrant IV is occupied by five sub-elements which are key elements to build a mangrove forest resource management strategy model.

**How to cite:** Melo, RH. (2024). Strategic Model for Mangrove Forest Resource Management in Boalemo District, Gorontalo Province. *Jambura Geoscience Review*, 6(2), 85-95. <https://doi.org/10.37905/jgeosrev.v6i2.24736>

## 1. INTRODUCTION

Mangrove forest management efforts in Boalemo Regency often encounter obstacles, the minimum number of existing mangrove forest management personnel and the lack of coordination of management institutions / agencies, while mangrove forest damage continues to increase due to degradation due to the pressure of population growth, especially in coastal areas, Along with the rapid increase in population and the need for people to meet their increasing needs, the amount of natural resource utilization is uncontrollable (Munawir et al., 2019; Rusdiyanto et al., 2020).

Currently, mangrove forests in Boalemo Regency are rapidly becoming depleted and damaged because most of the mangrove land has been converted into aquaculture ponds. Mangrove damage is certainly very dangerous for the ecosystem of fisheries resources, biodiversity and destroys the stability of coastal forests that support the protection of inland and rural agricultural crops and results in basic habitat and mangrove forest functions being lost (Istomo et al., 2020; Yoswatylet al 2022).

One strategy that can be applied in order to address personnel limitations and lack of coordination between institutions is to optimize the involvement of all existing stakeholders. The role of stakeholders is very important in mangrove forest management activities, considering stakeholders as actors of development and users of natural resources (Joandani et al., 2019).

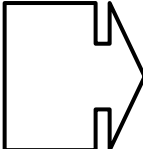
In mangrove forest resource management is often not optimal, because the management efforts undertaken are generally not well organized (Melo RH, et al 2019). Generally, management is not well planned, as well as management institutions do not fully have technical guidelines for mangrove forest resource management, most of these management institutions generally face obstacles such as the structure and management of institutions that are not running properly, mechanisms or unclear work operating standards.

Mangrove forest resource management institutions tend to be centralized and topdown, because they rely on their activities on the planning and financing of the central government, so that they seem only as implementers of activities, not leading to independence and empowerment of institutions. Existing mangrove forest resource management institutions should receive policy priority in mangrove forest resource management efforts in Indonesia (Melo RH, et al 2019). Research related to mangrove forest resource management institutions or organizations with the Interpretive Structural Modeling (ISM) method approach that produces effective management strategies is still very limited. ISM is a method for identifying relationships between certain elements, which has been widely used by researchers to describe the interrelationships of various determined elements (Darmawan, 2017; Iswahyudi, 2019; Marimin (2017; Sukwika T 2018) ISM is able to organize the complexity between system elements to be organized and directed, and become a tool to determine whether there is a relationship between these variables. (Melo RH, et al 2020) explains that ISM is one of the structuralization tools in descriptive modeling techniques that includes finding key sub-elements and the character of each sub-element as a useful knowledge base for planning strategic programs. Through the use of ISM, a structural model of the mangrove forest resource management strategy model was built. The ISM method also identifies key elements that are the main driving factors for other elements in strengthening mangrove forest resource management institutions in Boalemo district with the aim of designing a mangrove forest resource management strategy model.

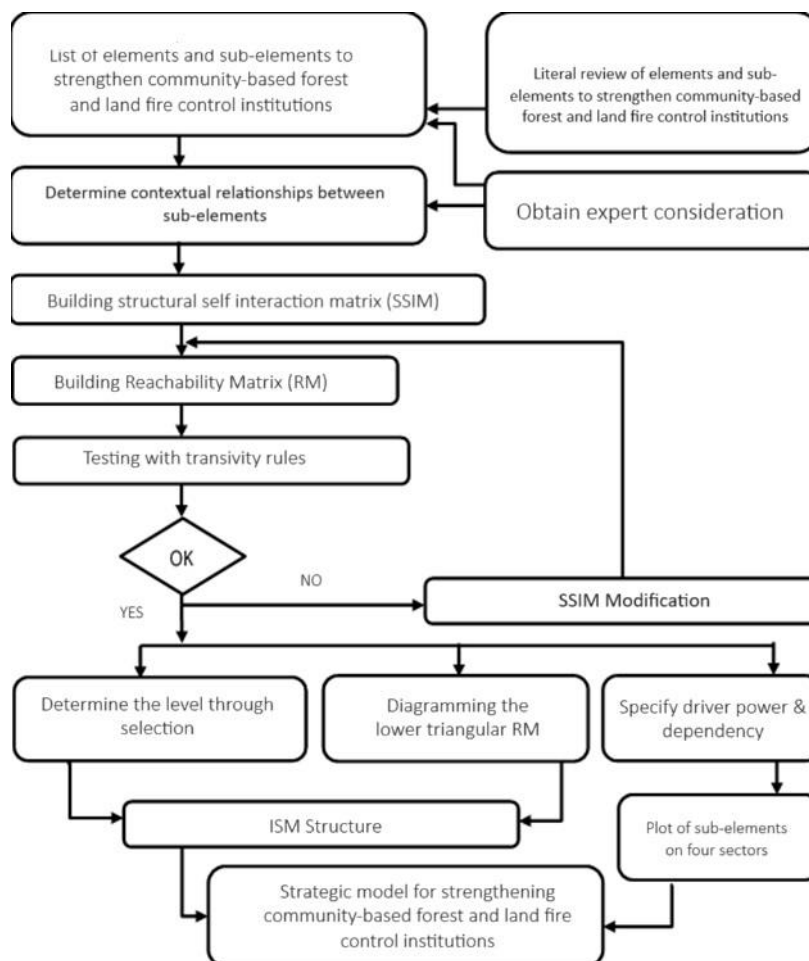
## 2. METHOD

The strategic model of mangrove forest resource management institutions is formulated using the Interpretive Structural Modeling (ISM) method. ISM is a structural method that has been used by many researchers to identify relationships or interrelationships between various elements in solving a particular problem. ISM provides a structural and directional framework for complex problems, and gives decision makers a realistic picture of their situation and the variables involved (Sukwika T 2018; Melo RH, et al 2020). The application of the ISM method is carried out through several stages following the flowchart as shown in Figure 1.

Contextual relationships between elements or sub-elements are formulated by constructing a structural self-interaction matrix (SSIM). The contextual relationship defined is an "influencing" relationship. The formulation is done through the assessment of pairwise contextual relationships on the matrix using the symbols V, A, X, and O, where:

V =	element (1) affects element (2), but not vice versa		V: $e_{ij} = 1; e_{ji} = 0$
A =	element (2) affects element (1), but not vice versa		A: $e_{ij} = 0; e_{ji} = 1$
X =	element (1) and element (2) affect each other		X: $e_{ij} = 1; e_{ji} = 1$
O =	element (1) and element (2) do not affect each other		O: $e_{ij} = 0; e_{ji} = 0$

The Reachability Matrix (RM) is constructed by converting the SSIM into a binary matrix. This process involves translating the symbols V, A, X, and O into numbers 1 and 0. The translation results are then further corrected to meet the transitivity rules, namely the fulfillment of the completeness of the causal loop. In building and testing the reachability matrix, researchers used the SisISM software tool.



**Figure 1** Flow chart of the stages of applying the ISM method (modified from Saxena 1992)

The final reachability matrix displays the level of each element or sub-element that will help in building the hierarchical structure of the mangrove forest resource management strategy model. The final reachability matrix also contains the driving force and level of dependency of each element or sub-element on other elements or sub-elements. To determine the key elements or sub-elements in the strategy of mangrove forest resource management institutions, each element or sub-element is further grouped based on its driver power and dependence level into four quadrants (Figure 2), (Melo RH, et al 2020) The four quadrants are classified as follows:

- Quadrant I, represents *autonomous factors*. Elements occupying this quadrant have weak driving force and dependence on other elements. This element has no or little relationship with other elements, and therefore its presence in the system does not have much effect. Elements occupying this quadrant can then be removed from the system (Iswahyudi, 2019).
- Quadrant II, is *dependent factors*. Elements in this quadrant are highly dependent and have weak driving force. Therefore, elements occupying this quadrant are not free, because they are highly dependent on other elements in the system.
- Quadrant III, represents *linkage factors*. Elements in this quadrant have a fairly high driving force, but also have a fairly high dependency.
- The elements contained in this quadrant require careful study in their application, as they have unstable relationships between elements in the system.
- Quadrant IV, is the *Independent factors*. This quadrant is populated by elements that have high thrust and weak dependency (tend to be independent). Elements in this quadrant have significant influence in the system, and are therefore key factors in building the model.

Quadrant IV (Independent)	Quadrant III (Linkage)
Quadrant I (Autonomous)	Quadrant II (Dependent)

**Figure 2** Four quadrants of ISM element grouping

The process of determining elements and sub-elements as well as filling out the questionnaire of pairwise contextual relationship patterns between elements or sub-elements involved thirteen expert respondents. Each expert was sought to represent various *stakeholders* related or interested in the forest resource management program *mangrove*. The selected expert respondents include representatives from the central government, local government, practitioners, universities and non-governmental organizations.

### 3. RESULTS AND DISCUSSION

#### 3.1. Elements then Sub-elements

In determining the elements to be analyzed using ISM, researchers generally refer to the 9 elements introduced by Hill and Warfield (2), namely the affected sector of society, the needs element, the main constraints element, the possible changes element, the objectives element of the program, the benchmarks element to assess each program objective, the activities element needed for action planning, the activity measures element to evaluate the results achieved by each activity, and the institutions involved. Researchers generally do not use all elements, but only one or a few elements that are considered necessary.

To achieve the goal of obtaining a hierarchical model of mangrove forest resource management strategies, this study uses the ISM element of program needs, which will be indirectly related to other elements including the objectives and activities required. While the sub-elements of the model-forming program needs element were determined as 13 sub-elements, namely: 1) Identification of mangrove forest resource characteristics, 2) Structuring the vision and mission of the institution, 3) Implementation of institutional legality, 4) Structuring an effective organizational structure, 5) Setting work operational standards, 6) Establishing main tasks and functions, 7) Establishing incentive and disincentive system, 8) Creating a sustainable financing system framework, 9) Conducting a coordination and cooperation system, 10) Increasing Community Participation in Mangrove Forest Resource Management, 11) Preserving mangrove forest resources, 12) Cultivating productive organizations, and 13) Fulfilling the recruitment system.

#### 3.2. Pattern of contextual relationship between sub-elements

The type of contextual relationship between the defined sub-elements is mutual influence or influence/affect. One sub-element of need affects or supports the fulfillment of another sub-element of need. Aggregating the results of expert opinion, the contextual relationship between the sub-elements of mangrove forest resource management program needs as contained in the SSIM table in Table 3.

Furthermore, the result data from the SSIM table is converted into a binary matrix of 1 and 0 into an initial reachability matrix. The conversion results are shown in Table 4.

No	Destination	13	12	11	10	9	8	7	6	5	4	3	2	1
1	Identification of mangrove forest resource characteristics	V	V	V	V	V	V	V	V	V	V	V	X	
2	Structuring the institution's vision and mission		V	V	V	V	V	V	V	V	V	V		
3	Implementation of institutional legality		V	V	V	V	V	V	V	V	V			
4	Structuring an effective organizational structure		V	V	V	V	X	X	V	A	A			
5	Establishment of work operational standards		V	V	V	V	V	V	V					
6	Define the main tasks and functions		V	V	V	V	V	V						
7	Establish an incentive and disincentive system		V	V	V	V	X	A						
8	Creation of a sustainable financing system framework		V	V	X	X	X							
9	Coordination and cooperation system		V	V	X	X								
10	Increase community participation		V	V	X									
11	Preserve mangrove forest resources		V	V										
12	Cultivating a productive organization		V											
13	Fulfillment of recruitment system													

**Figure 3** Structural self interaction matrix (SSIM) kebutuhan program pengelolaan sumberdaya hutan mangrove.

No	Destination	1	2	3	4	5	6	7	8	9	10	11	12	13
1	Identification of mangrove forest resource characteristics	1	1	1	1	1	1	1	1	1	1	1	1	1
2	Structuring the institution's vision and mission	1	1	1	1	1	1	1	1	1	1	1	1	1
3	Implementation of institutional legality	0	0	1	1	1	1	1	1	1	1	1	1	1
4	Effective organizational structure	0	0	0	1	0	0	1	1	1	1	1	1	1
5	Establishment of work operational standards	0	0	0	1	1	1	1	1	1	1	1	1	1
6	Define the main tasks and functions	0	0	0	1	0	1	1	1	1	1	1	1	1
7	Establish an incentive and disincentive system	0	0	0	0	0	0	1	0	1	1	1	1	1
8	Creation of a sustainable financing system framework	0	0	0	1	0	0	1	1	1	1	1	1	1
9	Creation of a sustainable financing system framework	0	0	0	1	0	0	1	1	1	1	1	1	1
10	Increasing community participation in management	0	0	0	0	0	0	0	1	1	1	1	1	1
11	Preserve mangrove forest resources	0	0	0	0	0	0	0	1	1	1	1	1	1
12	Cultivating a productive organization	0	0	0	0	0	0	0	0	0	0	0	1	1
13	Fulfillment of recruitment system	0	0	0	0	0	0	0	0	0	0	0	0	1

**Figure 4** Initial reachability matrix (IRM) kebutuhan program pengelolaan sumberdaya hutan mangrove

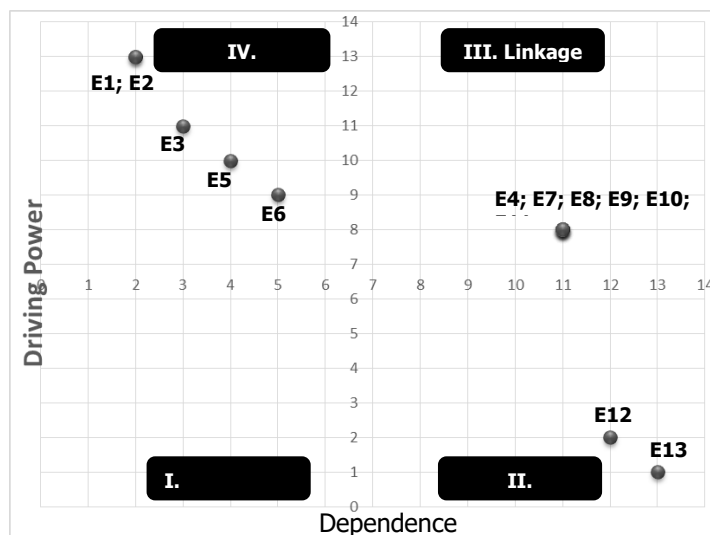


No. Elemen	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	Drive Pwr	Level
E1	1	1	1	1	1	1	1	1	1	1	1	1	1	13	I
E2	1	1	1	1	1	1	1	1	1	1	1	1	1	13	I
E3	0	0	1	1	1	1	1	1	1	1	1	1	1	11	II
E4	0	0	0	1	0	0	1	1	1	1	1	1	1	8	V
E5	0	0	0	1	1	1	1	1	1	1	1	1	1	10	III
E6	0	0	0	1	0	1	1	1	1	1	1	1	1	9	IV
E7	0	0	0	1	0	0	1	0	1	1	1	1	1	8	V
E8	0	0	0	1	0	0	1	1	1	1	1	1	1	8	V
E9	0	0	0	1	0	0	1	1	1	1	1	1	1	8	V
E10	0	0	0	1	0	0	1	1	1	1	1	1	1	8	V
E11	0	0	0	1	0	0	1	1	1	1	1	1	1	8	V
E12	0	0	0	0	0	0	0	0	0	0	0	1	1	2	VI
E13	0	0	0	0	0	0	0	0	0	0	0	0	1	1	VII
Dependence	2	2	3	11	4	5	11	11	11	11	11	12	13		
Level	VII	VII	VI	III	V	IV	III	III	III	III	III	II	I		

**Figure 5** Final Reachability Matrix (FRM) program needs for strengthening community forest and land fire control institutions

The IRM picture is then corrected with transitivity rules to produce a final reachability matrix (FRM) (Figure 5). Through FRM, the level of dependence and driver power as well as the rank/level of each sub-element of mangrove forest resource management strategy program needs can be determined.

The final results of processing contextual relationships as contained in the FRM table above show that sub-element 1 (Identification of mangrove forest resource characteristics) and sub-element 2 (Structuring the vision and mission of the institution) have the highest driving force or driver compared to other sub-elements. This suggests that these two sub-elements have a very significant influence on the system, or on the success of the mangrove forest resource management strategy program. Failure to identify the characteristics of mangrove forest resources and formulate and establish the vision and mission of the institution will negatively affect the system, and therefore affect the mangrove forest resource management strategy model. A clearer illustration of the level of driver power and dependence of each sub-element of mangrove forest resource management strategy program needs can be seen in Figure 6. The figure maps the location of each sub-element in four quadrants.



**Figure 6** Relationship between driving power and dependence

Classification of each sub-element into the driver power and dependence relationship diagram as shown in Figure 3 shows that none of the sub-elements of program needs occupy quadrant I (Autonomous). This implies that all sub-elements of program requirements have influence value in the system, and therefore do not need to be excluded from the system, or from the mangrove forest resource management strategy model to be built.

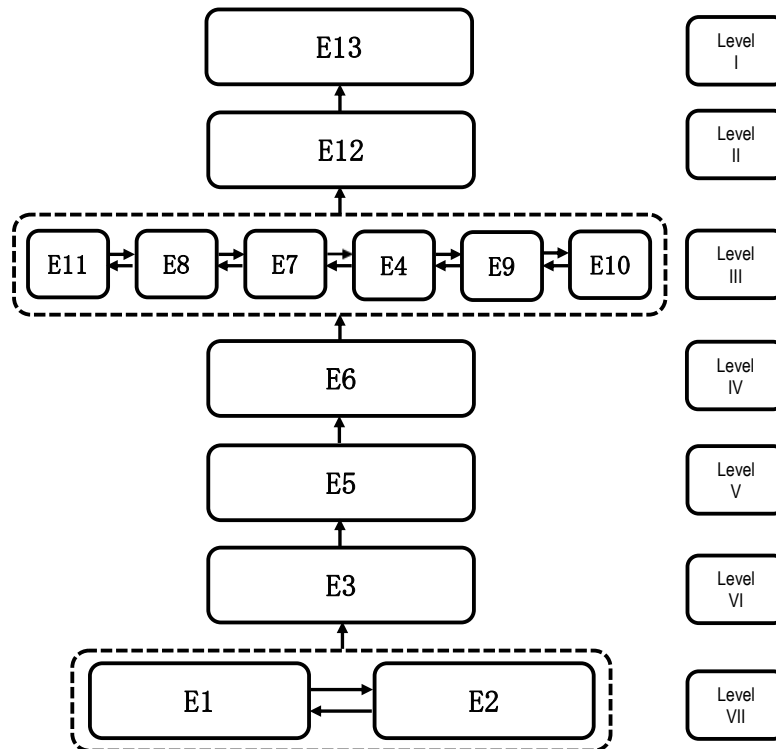
The sub-elements of cultivating a productive organization (E12) and fulfilling the recruitment system (E13) occupy quadrant II (Dependent), meaning that both sub-elements have a high dependency on other sub-elements, and have a weak driving force. The sub-elements of cultivating a productive organization and fulfilling the recruitment system are not free, because they are highly dependent on other elements in the system.

There are 6 (six) sub-elements that are classified into quadrant III (Linkage), namely structuring an effective organizational structure (E4), conducting an intensive and disincentive system (E7), creating a sustainable financing system framework (E8), conducting a coordination and cooperation system (E9), increasing community participation in mangrove forest resource management (E10), and preserving mangrove forest resources (E11).

The existence of the six sub-elements in quadrant III implies that they have a fairly high driving force or driving force, but also have a fairly high dependency. The six sub-elements in quadrant III require careful study and consideration in their application, because they have an unstable relationship between sub-elements in the system.

Quadrant IV (Independent) is occupied by 5 (five) sub-elements, namely identifying the characteristics of mangrove forest resources (E1), structuring the vision and mission of the institution (E2), implementing the legality of the institution (E3), structuring an effective organizational structure (E5), and determining the main tasks and functions (E6). The five sub-elements have high driving force and independence (weak dependence). Each sub-element significantly influences the system, and therefore the five sub-elements are categorized as key factors or sub-elements in building a strategic model for sustainable mangrove forest resource management in Boalemo District.

### 3.3. Structural Model of Sustainable Mangrove Forest Resource Management Strategy



**Figure 7** Diagram of sustainable mangrove forest resource management strategy

The structural model is built based on Driver Power and dependence of each sub-element in the system. Hierarchically, the model of sustainable mangrove forest resource management strategy built is depicted in Figure 7.

The Hierarchical Structure Model in Figure 7 above shows that the sub-element of identifying the characteristics of mangrove forest resources (E1) and the sub-element of mapping the vision and mission of the institution (E2) occupy the highest level of driving force or influencing power in the model. Both sub-elements must be formulated first and serve as a reference for the formulation of other sub-elements. In an institution, vision plays a significant role in setting strategic direction (Liao and Huang 2016), while mission statements improve organizational performance for vision achievement (Kholek et al., 2021; Sukristiyono et al., 2021).

The vision is the desired ideal condition, and always occupies the first step in strategic planning. The ideal condition in the vision is then formulated steps to achieve it through the development of the mission. The formulation of the mission describes the values and priorities of an institution in achieving the desired vision (Ikhsanudin & Basuni 2018).

In the management strategy of mangrove forest resource management institutions, the formulation of the vision and mission of the institution must be carried out together with identifying the vegetation characteristics of mangrove forest resources (Farahisah & Effendi 2021). Prioritizing the identification of mangrove forest resource characteristics is directed at efforts to adjust to the vision and mission to be formulated, so that it is not too broad. The vision and mission of the institution should adjust to the characteristics that exist in the research location, because each region has its own peculiarities. The results of research in several regions show that the principles of efforts to protect natural resources and the environment, including mangrove forest resources (Arfan, 2021; Ely et al., 2021; Joandani et al., 2019).

Management of mangrove forest resources with nuances of nature and environmental protection is expected to be animated or accommodated in the mangrove forest resource management strategy model. The values of mangrove forest resource management are not just animating the vision and mission of the institution, but are also expected to be adopted in the formulation of other sub-elements at the level below.

The form or values of mangrove forest resource management in the clearing of mangrove forest lands that are converted into ponds and residential areas need to be addressed carefully, and therefore need to be juxtaposed / escorted through an organizational vision and mission that is oriented towards natural sustainability, especially the protection of mangrove forest resources (Warningsih et al. 2019; Warningsih et al. (2021). This is to anticipate excessive clearing of mangrove land.

The next important sub-element in the structure of the management strategy model of mangrove forest resource management institutions after identifying the characteristics of mangrove forest resources and formulating the vision and mission of the institution, is the implementation of institutional legality (E3). The legality of the institution acts as a legal umbrella for the institution formed to be able to carry out its role, including in carrying out the functions of coordination and cooperation with other parties (Yoswaty et al. 2020; Manihuruk & Kartika 2022). One form of legalization of village-level institutions is through Village Regulations (Perdes). Perdes can be a form of revitalization of rules in mangrove forest resource management after being synchronized with the vision and mission of the institution. Village Regulations can be formed based on Law No. 12/2011 on the Formation of Legislation, which in article 8 paragraphs (1) and (2) states that regulations can be formed, recognized for their existence, and have binding legal force as long as they are ordered by higher laws and regulations or formed based on authority (Pemerintah RI 2011). Village regulations are stipulated by the Village Head after being discussed and agreed upon with the Village Consultative Body (BPD) (Pemerintah RI 2014a) Kuvaini A et al 2017).

After legalizing the institution, the next important step in the management strategy of mangrove forest resource management institutions is the establishment of work operational standards (E5), followed by the establishment of main tasks and functions (E6). In every natural resource management activity, where the legally authorized manager always occupies the position of the main stakeholder, this stakeholder acts as a maker of operational standards (Muji et al., 2018).

The description of the relationship between stakeholders shows the flow of relationships between stakeholders both written in the main tasks and functions document (tupoksi) and those



carried out in the field, this is intended to form an agreement and understanding of the concept of mangrove forest resource management (Edo Herlangga & Basuni, 2019).

The next stage in the mangrove forest resource management strategy model is structuring an effective organizational structure (E4), establishing an intensive and disincentive system (E7), creating a sustainable financing system framework (E8), conducting a coordination and cooperation system (E9). The formulation of the four sub-elements must consider or refer to higher levels (levels VI-VII). The four sub-elements located at level III have a mutually influencing relationship that is related to each other, so the formulation and implementation require careful study and consideration.

Cultivating a productive organization (E10) and fulfilling the recruitment system (E11) are respectively the last two stages that need to be built as part of the management strategy model of mangrove forest resource management institutions. Organizational culture is created first and then introduced to new members through the recruitment system. Organizational culture is a pattern of behavior that institutions must develop in overcoming external adaptation and internal integration problems, which will then be taught to new members to be able to adjust. Organizational culture must support the collective commitment of members to the achievement of common goals, and must foster competence and enthusiasm and good cooperation (Kurniawan & Karjun, 2019).

Organizational culture can have an effect on increasing motivation, job satisfaction, and personnel performance (Kurniawan & Karjun, 2019). The recruitment system can function as an initial filter to obtain personnel with potential capabilities and integrity according to the needs of the institution or organization in order to improve the quality of management institutions while forming productive human resources (Susan, 2019). To obtain long-term goals, the emphasis of the recruitment system is not solely based on the general cognitive aspects of prospective personnel, but also needs to pay attention to non-technical criteria including personality, interest, and motivation (Kurniawan & Karjun, 2019).

#### 4. CONCLUSIONS

Thirteen sub-elements of program needs were identified in building a structural model of management strategy for mangrove forest resource management institutions. Of the thirteen elements, five of them are key factors in building the model, namely identifying the characteristics of mangrove forest resources, structuring the vision and mission of the institution, implementing the legality of the institution, establishing work operational standards, and determining the main tasks and functions. The five key factors have high independence and driving force for other sub-elements, so they need to be prioritized in building a mangrove forest resource management strategy model.

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