Development Of Indonesia Submarine Force Structure Based On Analytical Hierarchy Process (AHP) And Interpretive Structural Modelling (ISM) To Control National Interest At Sea

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***Abstract*— as a maritime country, Indonesia is rich in natural resources, resulting in theft and territorial violations, so it needs to increase sea power, including submarines. Currently, Indonesia is developing submarines, so it is necessary to choose the best alternatives and elements to control national interests at sea. The research objectives are to find out the best alternative, the key element in developing submarine force structure, and the implications for national interests at sea. The research method is carried out by conducting a literature study to compile a questionnaire and consulting with experts to determine the best variables and sub-elements and followed by a survey of participants as a purposive random sampling using the analytical hierarchy process and interpretive structural modeling. From the research results, the five highest alternative variables are vision and mission (0.102), shipyard (0.90), government policy (0.84), technology transfer (0.56), and budget (0.53). Whereas the key sub-elements of development of submarine force structure are improving the quality of education, the need for the government's political will, national interests, national defense policy, and the role of the defense ministry. By increasing the submarine force structure will be able to maintain the national interest in the sea in protecting natural resources and prevent territorial violations.**

Keywords— submarine force structure, national interest at sea.

I. INTRODUCTION

Indonesia, as a maritime state, needs to maintain national interests in all territorial waters. The national interest is a specific policy to protect the physical, territorial, economic, and political aspects [1]. National interests need to be prepared on the basis of the geographical location where the state is located [2]. From the position of a country, geopolitics and geo-strategies can be developed that are able to identify the potential demographic of natural resources to improve people's welfare and economic growth. Indonesia's national interests are structured to realize the condition of the country's stability as the main condition in the sustainability of national development to achieve national goals.

Aspects of national interest are realized through the sovereignty aspects of the sea waters of national jurisdiction in the territorial sea (12 nautical miles) as well as sovereign rights in utilizing the results of natural resource resources in additional zones (24 nautical miles), Exclusive Economic Zones (ZEE-200 nautical miles) and landing continent. Indonesia's sovereignty and sovereign rights in accordance with UNCLOS 1982 over waters consist of inland waters and island waters of 3.11 million km^2, the territorial sea of 290.000 km^2, additional zones of 270 thousand km^2, exclusive economic zones (EEZ) of 3 million km^2 and landing continents 2.8 million km^2 [3]. The size of Indonesia's waters provides the potential for natural resources. On the other hand, it also demands the government to increase sea power to control the sea and prevent the use and control of the sea by the foreign military to achieve national interests. Indonesia's national interests at sea can be realized through the presence of the Navy, including submarine operations.

The national interests of a country are influenced by several aspects such as ideology, politics, economy, social culture, and national security [4]. Indonesia's national interests in the sea include the sea free from violence, the sea free from the dangers of navigation, the sea free from environmental damage, and the sea free from violations of the law [5].

Indonesia is currently developing submarine development in collaboration with Daewo Shipbuilding and Marine Engineering (DSME) [6]. Some countries also collaborate to build submarines using modern technology such as the Australian country [7]. Cooperation in the development of Indonesian submarines with DSME is carried out with the transfer of technology [8]. Submarine development will increase the impact of deterrence on state sovereignty [9]. In order to develop sea power, integration between institutions is needed [10]. This integration will enhance the ability to realize the building of Indonesian naval ships.

The process of the development of submarine force structure is related to various factors, both in terms of the policy, infrastructure, main industries, and supporting industries, technology, and human resources. Policy by the government is very important to the development of a submarine force structure [11]. Because of the policy will be able to synergize between institutions in realizing the development of submarine force structure that is able to provide a deterrent impact on foreign forces. In the

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aspect of submarine construction infrastructure, the shipyard industry in Indonesia has developed in line with the needs of shipping equipment at national and global levels. There are currently 250 shipyard industries in Indonesia [12]. Many national private and government-owned shipyard industries are capable of producing warships, especially surface warships [13]. Currently, PT PAL Indonesia cooperates with DSME to build class 209 submarines [8]. The collaboration is the construction of 3 submarine units with the stages of construction and connection of the 1st and 2nd ship modules at DSME Korea, and the connection to the 3rd ship module is carried out at PT PAL Indonesia [8, 14, 15]. The collaboration carried out through the transfer of technology activities to improve the ability of PT PAL Indonesia's human resources will improve efficiency in the shipbuilding process [8, 16]. The technology capabilities of submarine development will provide advantages over other countries' submarines [10, 16].

Submarine construction requires a preparatory stage, which includes: crew training facilities, infrastructure for submarine maintenance, spare parts preparation, and industrial development as well as sensor capabilities, navigation, and weapons control systems [17]. To build the strength of the submarine post, PT PAL Indonesia needs to improve infrastructure capabilities and HR skills to be able to build class 209 submarines for the Navy [18]. The importance of shipbuilding cooperation by increasing the ability of human resources in the aspects of design and skills, because the ability of human resources in the domestic shipyard industry is still limited [8, 19]. The development of the submarine force structure also requires supporting industries to supply ship equipment components [20]. With the support of industry, suppliers will increase the timeliness of submarine construction. In terms of technology, submarine development requires R&D activities towards the achievement of excellence over other similar products [20].

At present, the Indonesian team is building a class 209 submarine through a collaboration of transfer of technology with DSME Korea [8]. From the research, there is a research gap, if implemented with the conditions of the Indonesian state, especially on the elements that need to be prepared to facilitate the construction of submarines. In the construction of submarine force structure, preparation is needed, such are crew training, supporting industries, and infrastructure [17]. To raise submarine development requires government policy [8].

From the results of the study [8] about the class 209 Indonesian submarine development program and the submarine development methodology [17], researchers will conduct research on the development of submarine force structure programs. The purpose of this research is to analyze the components in the development of submarine force structure and strategies for realizing the development of submarine force structure. In order to achieve the goal of the development of submarine force structure, criteria and alternatives are arranged using the analytical hierarchy process. Meanwhile, to formulate a strategy that needs to be done is done by interpretive structural modeling (ISM) decision making.

II. METHOD

The study was conducted by determining the criteria and alternative variables that will be processed with AHP and research elements that will be obtained by ISM through literature study activities. From the selection of criteria and alternative variables as well as research elements consultation with the Indonesian team who involved in the class 209 submarine project at DSME Korea. From the results of the consultation, selected criteria were compiled, which included: policies, infrastructure, main industries, supporting industries, technology, and human resources for submarine personnel. Whereas in the decision-making element selected six elements which include: The national sector affected: the main constraints, possible changes, the purpose of the development of submarine force structure development program, activities needed for the development of submarine force structure and the institutions involved in implementing the program. From the results of the ranking, the researchers chose the best strategy using the interpretive structural modeling (ISM) model.

The selection of participants in the study was purposive random sampling from personnel who had the criteria for understanding the research objectives [21]. The research sample chosen was ten personnel from the team with the following criteria: (1) good knowledge of submarines, (2) working in submarine major, and (3) having been involved in projects making class 209 submarines at DSME Korea. The data obtained will be processed using AHP and ISM data processing techniques. Next, analyze the results of data processing of the development of submarine force structure on national interests at sea through triangulation with resource persons from the class 209 submarine procurement project team and reviewing with a literature study.

A. Select AHP priorities-based on criteria and alternatives

The AHP process is suitable for use in decision-making research models [22]. The stages of research using the AHP model include: (1) determining the problem, (2) constructing a hierarchical structure, (3) establishing pairwise comparisons, and (4) determining the best priority as a step in solving the problem [22, 23]. The selection of objectives, criteria, and alternatives in the development of submarine force structure is made through a comparison between criteria and between alternatives on each criterion. The ranking of criteria and alternatives with the aim of the development of a submarine force structure is done by using the expert choice 11 tools. Modeling the hierarchical relationship between criteria and between alternatives, as shown in Figure 1.

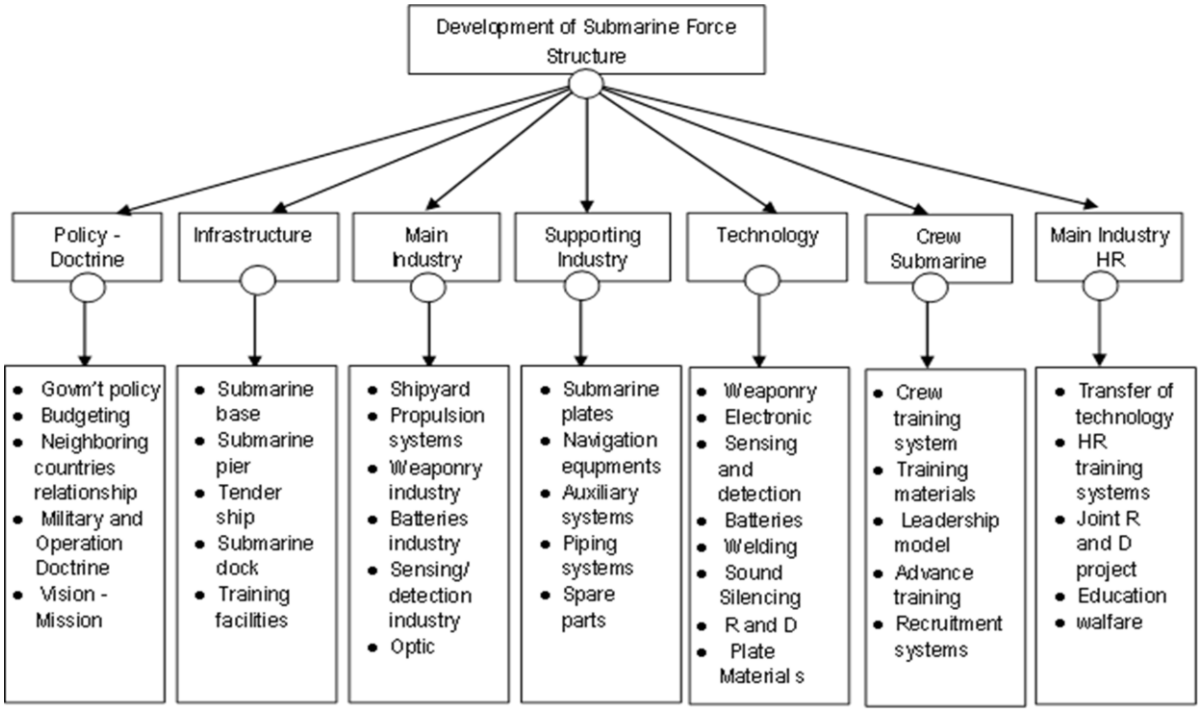

Figure. 1. Hierarchical Relationship Model.

B. Decision Making based on ISM

The selection of the best strategy for solving problems is carried out with nine elements, including social sectors, needs, constraints, alterables, objectives, objectives measures, activities, activities measures and agencies [24]. The development of submarine force structure on Indonesia's national interests is arranged in 6 elements, which include: affected sectors, main constraints, possibilities changes, program objectives, activities needed, and the institutions involved.

The stages in processing data using ISM are carried out in stages: (1) construct a structural self-interaction matrix (SSIM), (2) construct a reachability matrix (RM) by changing V, A, X, O with numbers 1 and 0, (3) conduct transitivity checks and (4) create a canonical matrix (CM) by constructing the model as a solution to ranking the model [24, 25]. In the development of the submarine industry against the national interests of Indonesia at sea arranged in 6 elements according to table 1

TABLE 1.
LINKAGES BETWEEN SUB-ELEMENTS

No	Element	Interpretation
1	The affected sectors	i more influence than j
2	The main constraints	i more contributes than j
3	Possibilities changes	i more important than j
4	Program objectives	i more important than j
5	Activities needed	i more priority than j
6	The institution involved	i more influence than j

III. RESULTS AND DISCUSSION

A. Variable criteria and alternative development of submarine force structure.

The results of data processing development of submarine force structure with the analytical hierarchy process (AHP) model on the criteria and alternatives with expert choice 11 software can be described as follows:

1. Criteria in the construction of the submarine force structure

From the seven criteria, it can be explained that the results of the assessment: policy-doctrine (0.289), main industry (0.242), main industry human resources (0.164), submarine crew capabilities (0,129), infrastructure (0,077), technology (0,61) and supporting industry (0,38) as shown in figure 2.

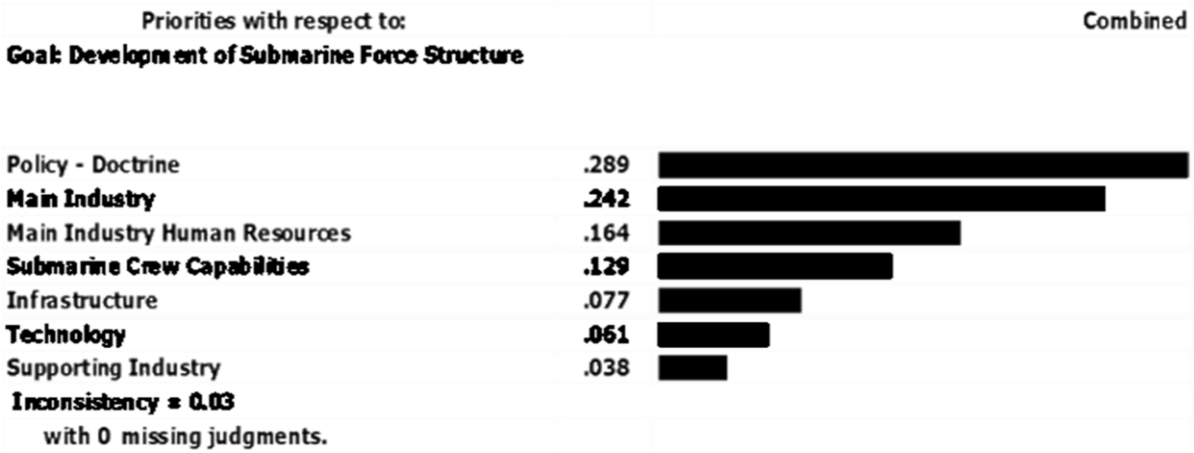

Figure. 2. AHP Process Results On The 7 Criterias.

These policies will be realized well if the main industries have good capabilities in terms of facilities and human resource capabilities. The level of submarine sophistication is also determined by the ability of the main industry and supporting industries (Schmidt, 1992).

2. Selection of the best alternative

Data processing using analytical hierarchy process (AHP) model with Expert Choice 11 software, from 10 participants in 7 criteria, the following alternative results were obtained:

a. Policy - Doctrine

The results of data processing on the criteria of policy - doctrine: vision and mission (0.353), government policy (0289), budgeting (0.184), neighboring countries relationship (0.111), and military doctrine (0.062) as shown in Figure 3.

These policies will be realized well if the main industries have good capabilities in terms of facilities and human resource capabilities. The level of submarine sophistication is also determined by the ability of the main industry and supporting industries (Schmidt, 1992).

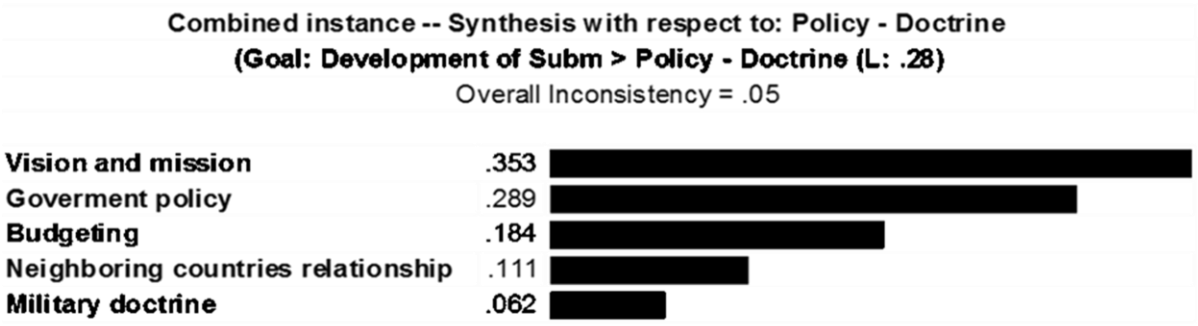

Figure. 3. AHP process results on policy-doctrine criteria

b. Main industry

The results of data processing on the main industry criteria are as follows: shipyard (0.374), propulsion system (0.219), submarine weaponry (0.176), batteries industry (0.106), sensing - detection industry (0.082) and optical industry (0.43) as shown in Figure 4.

The development of a shipyard that is supported by adequate facilities is an important facility to develop the submarine force structure. The shipyard also needs other major industries to develop the submarine industry, such as the propulsion industry and the weaponry industry. The importance of the weapons industry is the technological secrecy of the weapons industry has a deterrence effect on the efforts of foreigners who intend to carry out aggression [10].

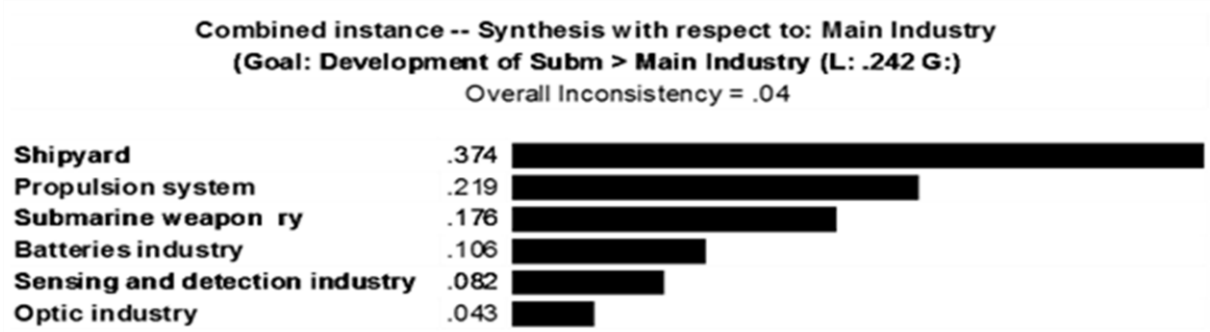

Figure. 4. Results of the AHP process on the main industry criteria

c. Human Resources of Main industry

The result of data processing on the main industrial HR criteria such is technology transfer activities (0.342), (training systems (0.292), (joint R & D projects (0.194), education (0.102), and welfare (0.071) as shown in Figure 5. Technology transfer activities have the effect of increasing the speed of Human Resources capabilities in submarine building activities. It is not uncommon that shipyards, where the technology transfer program is carried out, do not provide flexibility and ease in accessing data and technology. Thus we need good strategies and techniques in the process of transfer of technology (Sulistijono, 2017).

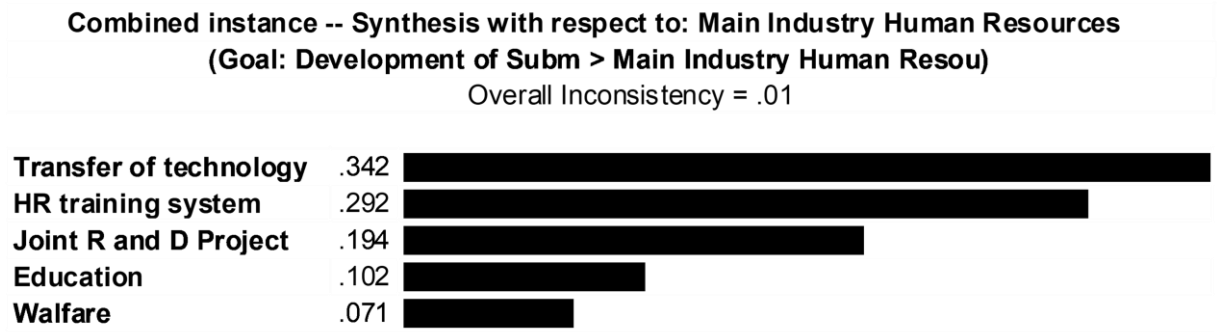

Figure. 5. Results of the AHP process on the human resources of main industrial criteria

d. Submarine crew capability

The result of data processing on the submarine crew capability criteria such is crew training system (0.308), training material (0.280), leadership model (0.214), advanced training (0.138), and the recruitment system (0.059)) as shown in Figure 6. Training systems and training materials need to be well prepared to produce skilled and agile submarine crews. Submarine deployment requires special expertise, especially sensitivity in detecting the presence of opponents and opposing weapons.

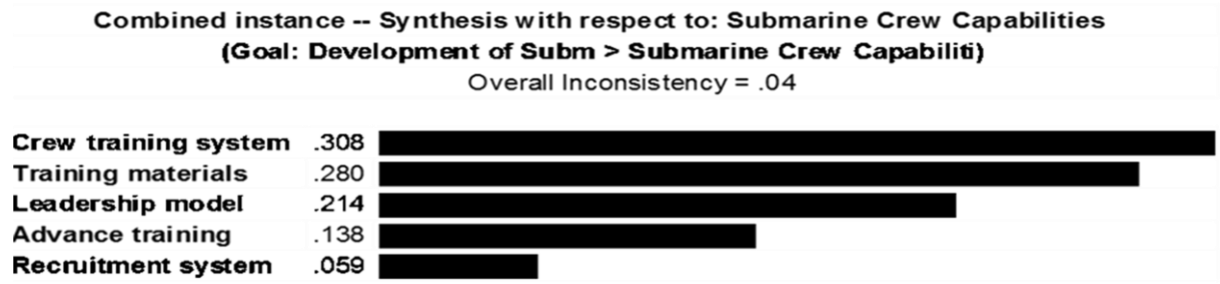

Figure. 6. Results of the AHP process on the submarine crew capabilities criteria

e. Infrastructure

The results of data processing on the infrastructure criteria are as follows: submarine dock facilities (0.311), submarine pier (0.269), submarine naval base (0.206), training facilities (0.161) and tender ship (0.054) as shown in Figure 7. Submarine docking facilities are

important, especially for ship maintenance activities. In addition to the ship, the dock is the existence of a tender ship that functions as a mother vessel for submarines during operational activities. This tender ship is needed, especially in areas that do not have a dock docked by submarines (Schmidt, 1992). The tender ship functions as a supporting vessel for fuel and food supplies. The tender ship will follow where the submarine is operated

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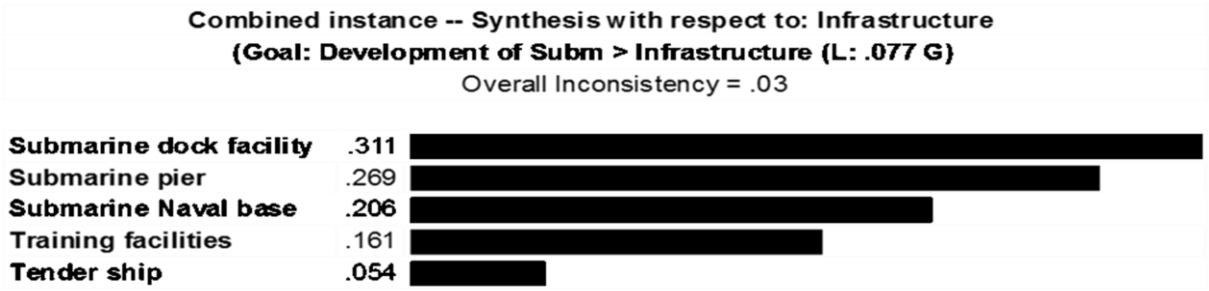


Figure. 7. AHP process results on infrastructure criteria

f. Technology

The results of data processing on the technology criteria are as follows: welding system (0.251), batteries system (0.214), sensing and detection (0.163), submarine weaponry (0.138), sound and silencing system (0.093), electronic system (0.065), plate material (0.047) and R and D activities (0.029) as shown in Figure 8.

The welding system is important to master because it gives the submarine ability to reach the deepest point in underwater conditions (Bishop, 2003; Piella, 2014). Welding capabilities need to be supported by R and D (Kulkarni, 2015). The ability of battery technology will have an effect on the ability to store electricity when diving.

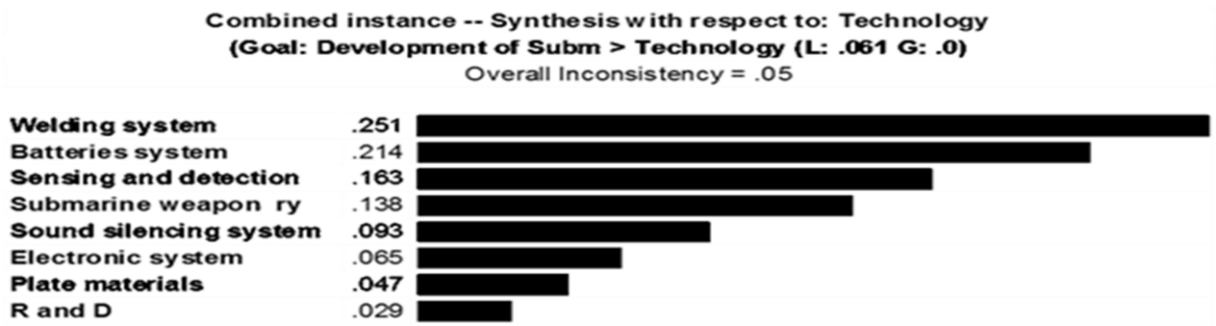


Figure. 8. Results of AHP process aspects of technological criteria

g. Supporting industry

The results of data processing on supporting industry criteria are as follows: submarine plates (0.318), auxiliary systems (0.268), navigation equipment (0.186), piping system (0.149), and spare parts (0.079) as shown in Figure 9. The submarine plate industry is important because it will affect the ability of the ship when diving. The better the quality of the submarine will have the ability to dive in-depth, it will be able to avoid the reach of the torpedo. In order to support the sustainability of the life cycle of the submarine, it needs to be supported by the availability of adequate spare parts

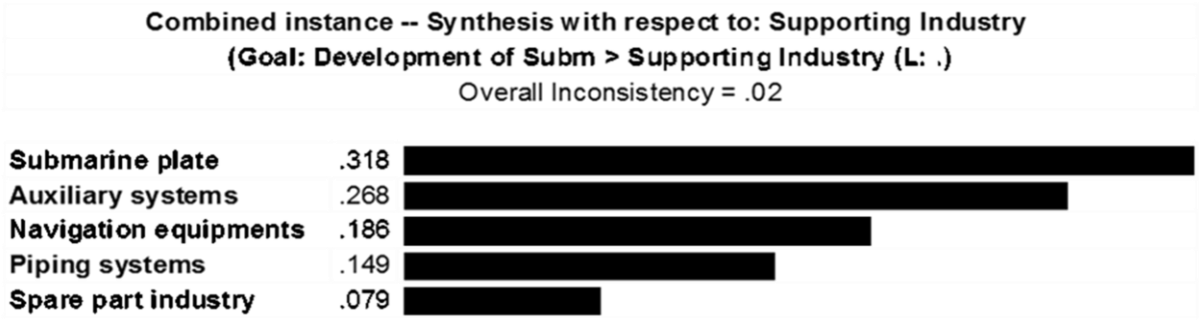


Figure. 9. Results of the AHP process on supporting industry criteria

3. Combined result

In a combination of all the alternatives from the seven criteria, the highest five alternative ranking results are obtained as follows: vision and mission (0.102), shipyard (0.090), government policy (0.084), transfer of technology (0.056) and budgeting (0.053) as shown in Figure 10.

Defense vision and mission provide guidance to achieve targets in the field of defense. To improve the ability of the submarine crew, a training system and training materials are needed in accordance with the submarine to be operated (Schmidt, 1992). In order to improve the ability and skills of submarine crew members, further training is needed periodically.

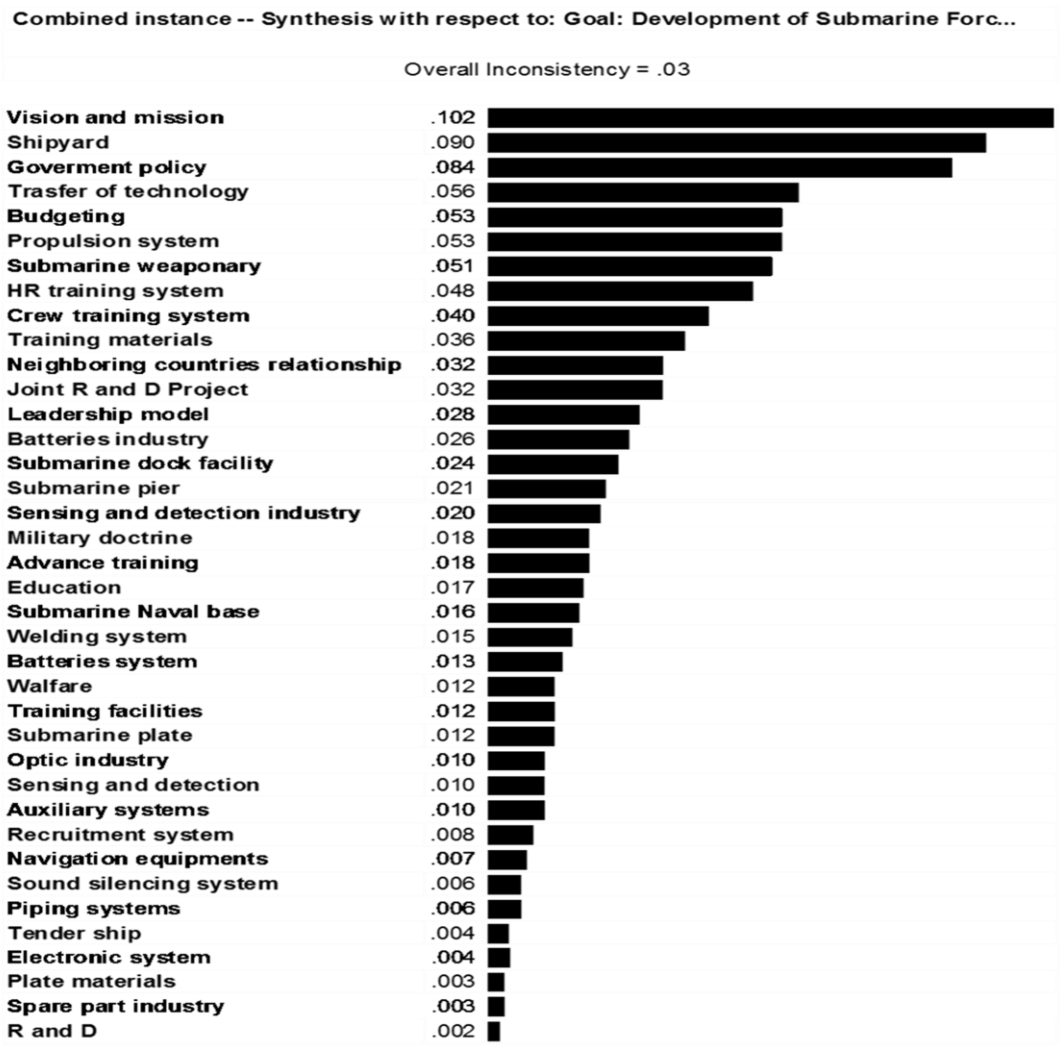


Figure. 10. Results of the combined AHP process for all alternatives

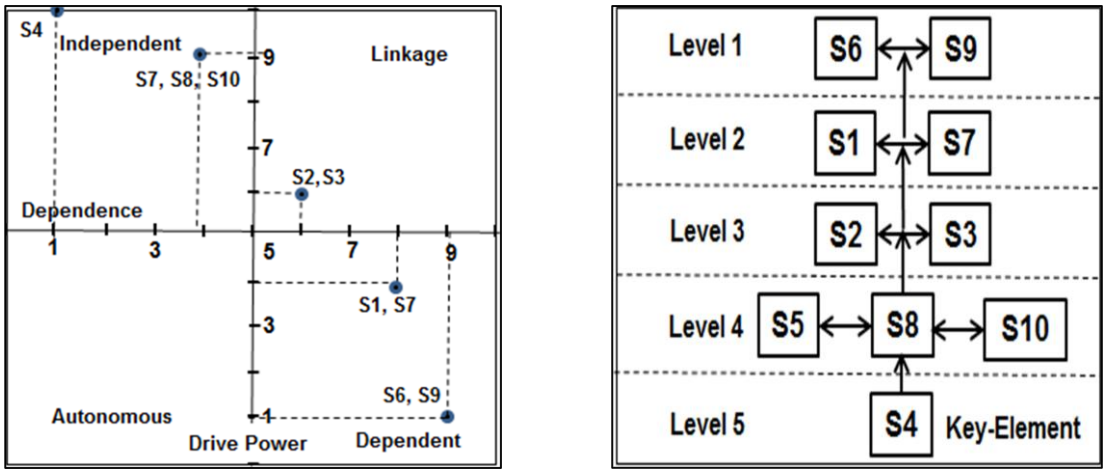
B. Key Elements of building submarine force structure

Data processing using interpretive structural modeling (ISM) with Eximpro software, from 10 participants on six elements obtained the results of key sub-elements as follows:

1. The affected sectors

The results of data processing on the affected sectors, as key sub-elements of the development of submarine force structure, are improving the quality of education (S4), followed by research and development (S5), industrial employee training (S8) and technology mastery (S10). Next, followed by the main industrial sector (S2), supporting industries (S3), national defense facilities (S1), crew education and training (S7), national jurisdictional waters security (S6), and employment (S9) as shown in Figure 11.

This indicates that in order to improve the development of submarine force structure, quality education is needed. In order to improve the capabilities of the main industries, it is necessary to build shipbuilding industries, engines, batteries, and weapons [17]. Increasing supporting industries is done by increasing the ability of industrial auxiliary engine, sensing, navigation, and sensor products.



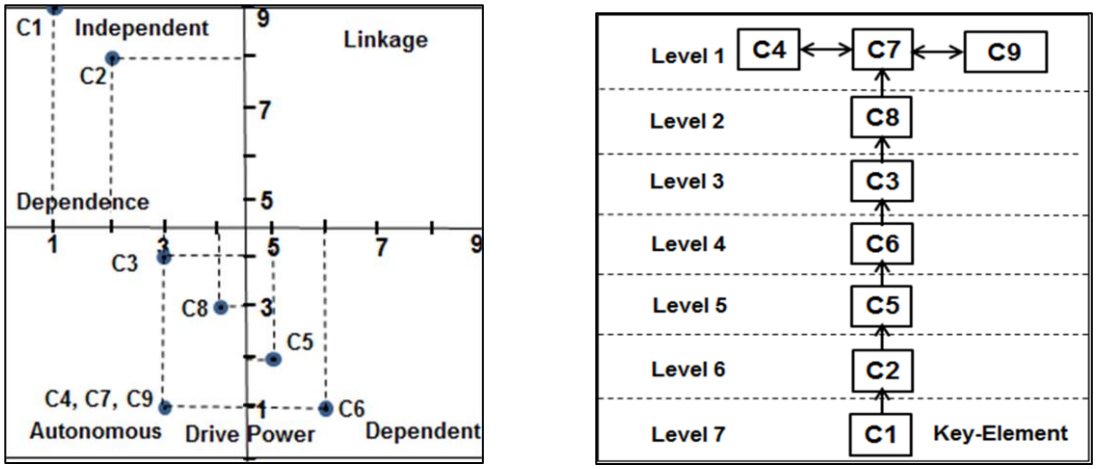
(a) Drive power and dependence diagram (b) Structural Model

Figure. 11. Results of selecting the affected sector elements

2. The Main constraints

The results of participant data processing on the main constraint elements as key sub-elements are lack of government political will (C1). Government political is followed by (C1), limited defense budget support (C2), the limited ability of main industries (C5), limited supporting industries (C6), low technology mastery (C3), the low capability of industrial employees (C8), limited facility infrastructure for submarine fleets (C4), low crew capability (C7) and limited educational facilities (C9) as shown in Figure 12.

This lack of political will is reflected in policies towards the main industries and supporting industries that have not been well managed. Although the current defense budget has increased, compared to the national budget, it is 0.8 percent in other countries such as Singapore and Australia in the range of 2 percent of Gross Domestic Product (GDP).



(a) Drive power and dependence diagram (b) Structural Model

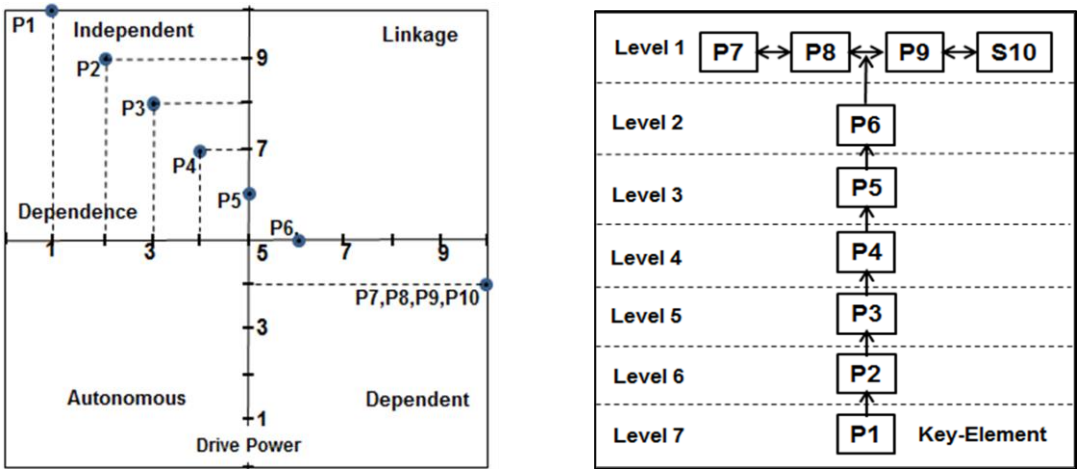
Figure. 12. Results of selecting the main constraint elements

3. The possibilities changes

The results of data processing on the elements of change that are possible to be done can be identified as a

key element is to realize the national interest (P1). Changes to elements of national interest (P1) will affect defense programs (P2), vision and mission of defense institutions (P3), defense strategies (P4), defense doctrine (P5) and maritime doctrine (P6), budget support (P7), patterns technological collaboration with Higher Education institutions (P8), patterns of cooperation with foreign industries (P9) and patterns of R and D activities (P10) as shown in Figure 13.

National interests that have been prepared in accordance with the mandate of the law are temporary in accordance with the government policy program. National interests should be structured with potential threats to state sovereignty. National interests compiled through defense policies and doctrines must be able to lead to safeguarding national resources, especially in the oceans, which have not been well managed and supervised to increase national prosperity and prosperity.

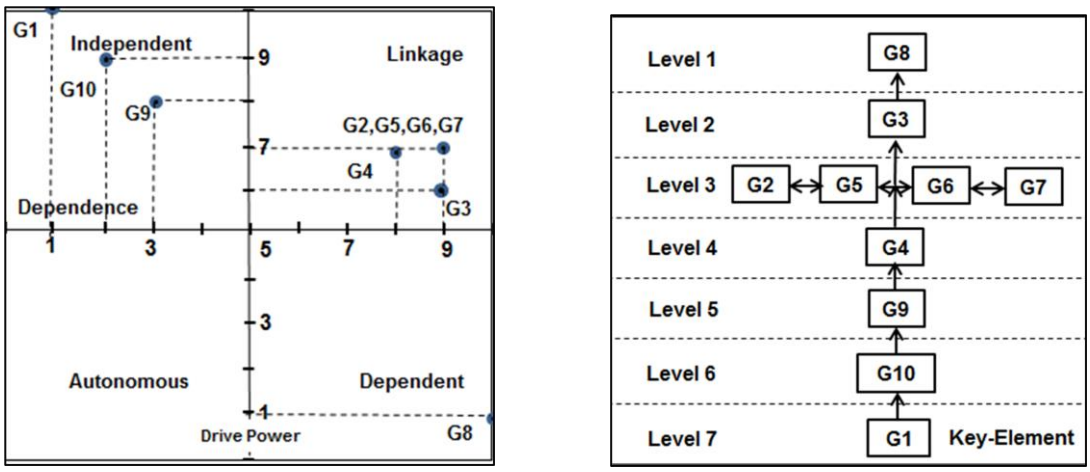


(a) Drive power and dependence diagram (b) Structural Model

Figure. 13. Results of selecting possible change elements

4. *The program objectives*

The results of data processing on the program's objective element as a key element are state sovereignty (G1). The aim of the next program is to increase technological capability (G10), increase industrial production (G9), prevent territorial violations (G4), improve national jurisdictional water security (G2), improve the security of natural resources at sea (G3), increase the impact of deterrence (G5)), increase the country's existence (G6), prevent crime at sea (G7) and absorb labor (G8) as shown in Figure 14. Increasing state sovereignty is the main element needed in the administration of the state. The sovereignty of this country has a broad meaning for every action taken by the government. With sovereignty, a country will be able to manage natural resources to increase economic growth. State sovereignty supported by the security of national jurisdictional waters and the security of natural resource management has the effect of increasing employment



(a) Drive power and dependence diagram (b) Structural Model

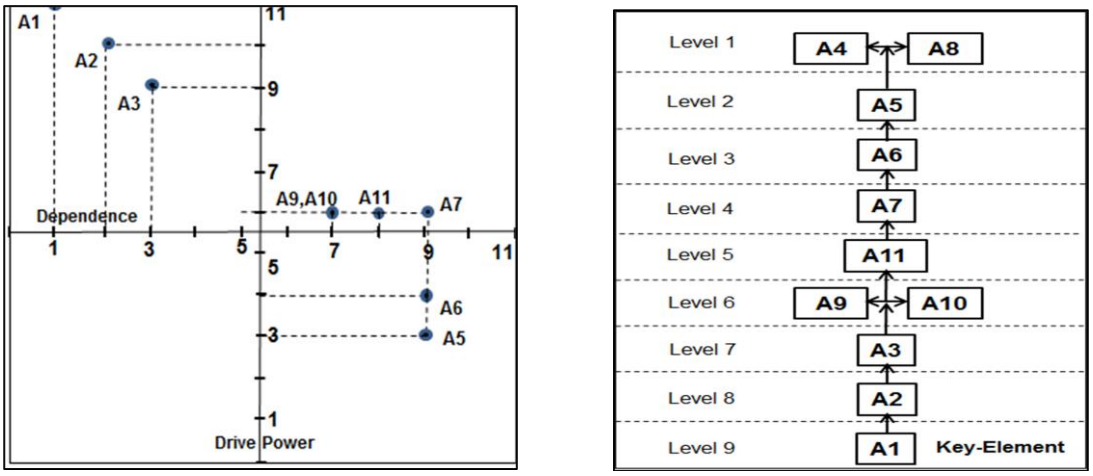
Figure. 14. Results selection of elements of program objectives

5. *Activities needed*

The result of data processing on the activity element needed as a key element is the national defense policy (A1). The next required activities are analysis of defense force structure needs (A2), defense budget support (A3), submarine fleet infrastructure readiness (A4), major

industry readiness (A5), supporting industry readiness (A6), enhancement of human resource technology capabilities in the submarine industry (A7), recruitment, education and training ABK (A8), R and D (A9), collaboration with Higher Education institutions (A10) and cooperation with foreign industry (A11) as shown in Figure 15.

The right national defense policy is able to support the improvement of the ability of submarine force structures. This will be supported by infrastructure readiness of the submarine fleet and readiness of the main industries (shipyards, machinery, weapons, sensing, and detection) through cooperation to improve mastery of submarine technology [10, 16].



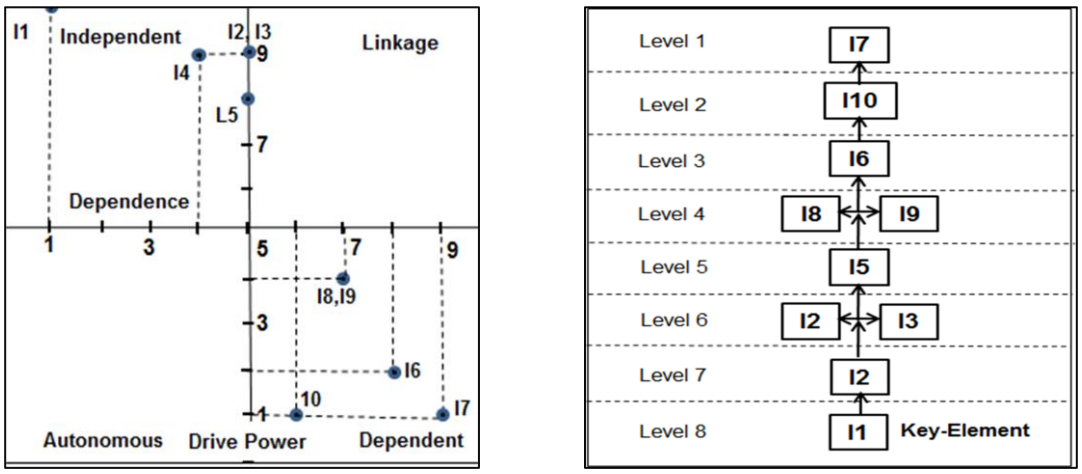
(a) Drive power and dependence diagram (b) Structural Model

Figure. 15. Results of selecting the required activity elements

6. The institution involved.

The results of data processing on the elements of institutions involved as sub-elements of the council are the Ministry of Defense (I1). The next important institutions are the Ministry of Reset and Technology, (I2), the Ministry of finance (I3), the TNI Commander (I4), the Navy Chief of Staff (I5), the main industry parties (I6), the supporting industries (I7), research and development (I8), tertiary institutions (I9) and crew education and training institutions (I10) as shown in Figure 16.

To realize the development of the submarine force structure, the role of the Ministry of Defense is key. With policies issued by the ministry of defense to improve the country's defense system, it has an influence on defense forces. The role of the ministry of defense will be followed by enhancing the ability of the Indonesian national army to maintain the country's sovereignty so that the Indonesian state can manage its resources to enhance the economic growth and prosperity of the people [1].



(a) Drive power and dependence diagram (b) Structural Model

Figure. 16. Results selection of elements of program objectives

C. Implications of the development of submarine force structure on national interests at sea.

According to figure 17, it can be explained that the development of submarine force structure is influenced by the policies of the ministry of defense, the main

industry, supporting industry, technology, submarine infrastructure, and the ability of the crew [18]. A strong submarine force structure will increase the ability of a country navy to control the sea and prevent sea used by opponents, from the ability of aspects of sea control and prevention of sea used by opponents, the impact of deterrence of foreign powers that intends to disrupt the sovereignty of the state.

With the condition of the country's sovereignty at sea, It has an effect on the country's ability to realize national interests at sea, which include: freedom of navigation, free from violence, free of environmental damage, and free from violation of the law. By achieving national interests at sea, the community and the government can manage maritime resources to increase economic growth and community welfare.

In order to address the development of a submarine force structure that has an influence on national interests at sea, budgetary support is needed to improve the technological capabilities implemented through education and training.

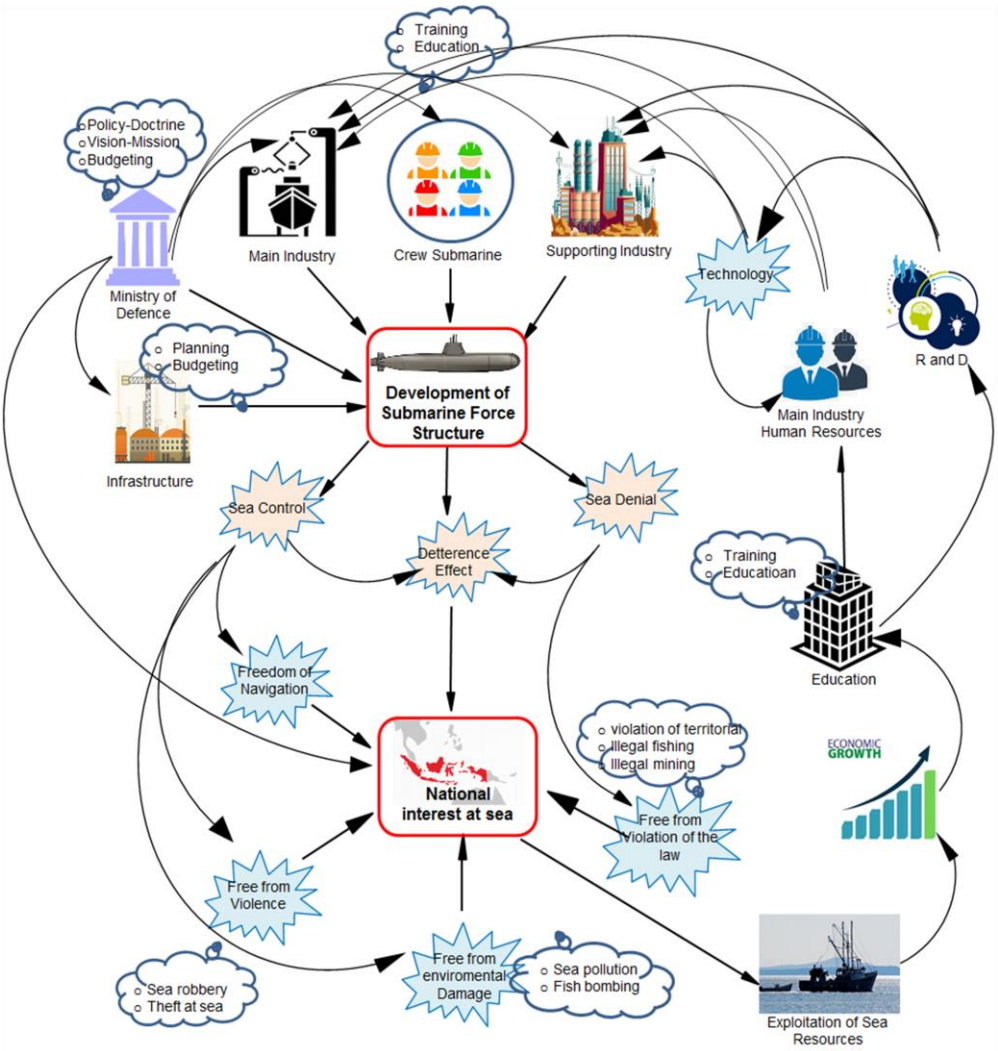


Figure. 17. Rich picture

IV. CONCLUSION

A. Conclusion

From the results of research into the development of the submarine force structure to support the interests of the country, it can be concluded as follows:

1. Develop submarine strength structures based on government policies compiled in the national defense system through the vision and mission of building the aircraft carrier industry in shipyards and supporting industries. In order to support the upgrading of key industries, An adequate budget is needed to support technology, R, and D. transfer activities.
2. The development of a submarine force structure will provide an increase in the ability of the state to control the sea (sea control) so that it cannot be used by foreign interests (sea denial). Both of these aspects will increase the impact of a country's deterrence
3. The development of submarine force structures will increase the interest of the state: freedom of navigation, freedom from violence, freedom from

environmental damage, and freedom from violation of the law. By achieving national interests at sea, the community and the government can manage marine resources to enhance economic growth and community welfare.

B. Suggestion

To improve the development of the submarine force structure can support:

1. Enhancing human resource capabilities in submarine development through collaborative and research institutions in research institutions and domestic tertiary institutions as well as collaboration and technology transfer with overseas shipyards.
2. Increased industrial capability issued: propulsion systems, weapons systems, detection systems, and battery industries, through a planned and integrated coaching program between the Ministry of Defense, the Ministry of Industry and the Defense Industry Policy Committee (KKIP).
3. The government needs to improve the main industries and supporting industries because, in other aspects, improving competence and product quality will be able to create new jobs.

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