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Submarine Capability Assessment Model Using Analytical Hierarchy Process (AHP) and System Dynamics

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Abstract	Regional dynamics marked by the increase in submarine operations by several countries need to be balanced with increasing Indonesia's capabilities in underwater warfare and contributing to increasing the deterrence of the country's defense system at sea. Therefore, the aim of this research is to consider the competitive dimensions of the development of submarine capabilities on the deterrence effect of a country and assess the extent of the discussion in the literature review. This research is a statement that there is no instrument for assessing the capability and sustainability of submarines in an effort to increase the deterrence effect in the ALKI II area which is linked to current dynamic developments so that this research is expected to contribute to obtaining an instrument for assessing submarine capability and the deterrence effect of submarines. in the ALKI II area.
Keywords	ALKII, Capability, Distress Effect, Submarine, Submarine Capability

PENDAHULUAN

After establishing Indonesia's status as an archipelagic country, Indonesia has ratified the United Nations (UN) Convention on International Maritime Law (UNCLOS 1982). In order to increase maritime defense capabilities, the Indonesian Navy (TNI AL) has a submarine unit which is an important part of defense equipment and strategic weapons. Modern conventional submarines have very important capabilities in increasing maritime defense capabilities.[1] In the future, several possible submarine developments can be carried out in Australia and ASEAN countries. Changes in a country's strategy and security system are greatly influenced by the dynamics of the strategic environment which continues to develop and change. In this research, it is hoped that it can provide an assessment model that can measure submarine capabilities and the

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[1] (Andersșon, 2015)

effects of submarine deterrence. A country must be able to retaliate if it experiences an attack, either directly when there is an indication of attack from an opponent that has the ability to counter-attack safely from submarine missiles (Andersson, 2015). In the international environment, the security dimension is a top priority so that every country will try to strengthen security by increasing military expenditure. When a country increases its military strength, other countries will do the same.[2]

Regional dynamics marked by the increase in submarine operations by several countries need to be balanced with an increase in Indonesia's capabilities in underwater warfare.[3] Indonesia's 2024 Defense Strategic Plan to develop a submarine fleet.[4] Analyzing the relationship between external, internal and operational factors of submarines on the deterrent power of the country's defense system explains that submarines can contribute to increasing the deterrent power of the country's defense system at sea.[5] Therefore, the aim of this research is to consider the competitive dimension of submarine capability development to analyze the capability for deterrence effects in the ALKI II region.

Military deterrence strategies are dynamic, through the preparedness of defense forces to face actual threats in the form of war or other forms of military threats. In times of peace, the presence of submarines has a major deterrent effect on other parties, thereby strengthening the government's diplomatic efforts. [6]. Alfred Thayer Mahan, his views became the basis for large countries in achieving greatness to become ideal maritime countries. Mahan emphasized the importance of large countries building maritime power that is evenly distributed throughout strategic areas. Capability theory is an important concept in understanding individual potential and opportunities. Capabilities are a set of opportunities and are specific to an individual, which can significantly influence their life. In the concept of strategy, deterrence is always in harmony with defense and focuses more on military capabilities. According to Robert Jervis in his book Rational Deterrence: theory and evidence, in this theory, the actor attempts to increase his ability and strength to ward off an attack from an opponent, or at least pressure and force the opponent to

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[2] Muhammad Harry Riana Nugraha, "Perencanaan Strategis Pertahanan Masa Depan Indonesia: Analisis Pada Lingkungan Strategis Asia Tenggara (Asean) Periode 2015-2020," *Jurnal Pertahanan & Bela Negara* 7, no. 3 (2017): 157–67.

[3] Faculty of Defense Strategy, "DEFENSE UNIVERSITY OF INDONESIA JAKARTA JANUARY 2014," 2014.

[4] (Andersson, 2015)

[5] Timbul Haryanto AR, A. Octavian, and Romie O. Bura, "Analysis of the Influence of Submarine Operational Capabilities on the State of Deterrence," *Journal Research of Social, Science, Economics, and Management* 1, no. 7 (2021): 759–66, https://doi.org/10.36418/jrssem.v1i7.95.

[6] Defense, "INDONESIAN DEFENSE UNIVERSITY JAKARTA JANUARY 2014."

think again about carrying out an attack. The aim of using the military is to make opposing parties aware of the risks they face if they carry out an attack. The means used to implement deterrence policies can be the use of weapons of mass destruction (WMDs), conventional weapons power, increasing military capabilities in general, forming alliances, economic sanctions or embargoes, and threats of retaliation.

This research is in line with previous research conducted by Timbul Haryanto AR (2022). From the literature, there is no instrument for assessing submarine capabilities in an effort to increase the deterrence effect in the ALKI II area, which is related to the development of dynamic changes in the ALKI II environment regarding the relocation of the country's capital. Apart from this, the rapid development of submarine technology owned by neighboring countries, the Indonesian Navy needs to balance these changes in an effort to maintain and increase the deterrence effect of Indonesian Navy submarines. This research is expected to provide an instrument that can measure submarine capability and the deterrence effect of submarines in the ALKI II area.

As an analytical approach, this research adopts a qualitative descriptive statistical method to provide an overview of the research subject to create a basis for researchers in collecting more comprehensive data using Delphi-AHP-Fuzzy integration. This research can provide a new picture and insight into the hierarchical model between submarine capability factors and submarine deterrence effects as a key to developing knowledge in determining submarine capability assessment instruments. This research is focused on ASEAN countries that have interests in the ALKI II area. This research is also supported by 9 expert panels as targets for distributing the questionnaire.

Thus, increasing submarine capabilities will contribute to renewing the Indonesian Navy's deterrent and striking power. Deterrence theory suggests that extended deterrence threats tend to be more effective when potential challengers perceive them as capable and worthy of trust.[7] To obtain information about capabilities at the individual level, you can use a capabilities approach by developing a survey instrument.[8]

Novelty in this research, the submarine capability assessment model uses the Analytical Hierarchy Process (AHP) and a dynamic system developed to measure the submarine's ability to

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[7] Jesse C. Johnson, Brett Ashley Leeds, and Ahra Wu, "Capability, Credibility, and Extended General Deterrence," *International Interactions* 41, no. 2 (2015): 309–36, https://doi.org/10.1080/03050629.2015.982115.

[8] Paul Anand et al., *The Development of Capability Indicators*, *Journal of Human Development and Capabilities*, vol. 10, 2009, https://doi.org/10.1080/14649880802675366.

improve maritime security. This model is different from previous research which only used ordinary statistical methods, so it can provide more accurate and realistic results.

GAP Research on submarine capabilities usually only focuses on technical and strategic aspects, but does not pay attention to the dynamics of the continually developing strategic environment. Therefore, this research will fill this GAP by integrating dynamic system analysis to predict changes in the strategic environment and measure submarine capabilities more accurately. The aim of this research is to develop a submarine capability assessment model that uses AHP and dynamic systems to measure the ability of submarines to improve maritime security and predict changes in the strategic environment.

METODE

The stages of the research method that will be used in this research include the literature review stage, criteria weighting using the AHP method and scoring criteria and sub-criteria using Likert, then simulated using a dynamic system. To obtain literature reviews for international journals, researchers used Harzing's Publish or Perish 8 application software using the keywords capabilities, submarine capabilities, deterrence effect. in the range of control years between 2012 to 2023. The criteria and sub-criteria obtained were validated using the Content Validation Index (CVI) by distributing questionnaires to expert personnel. The formula for calculating CVI (Lawshe, 1975) is

$$CVI = \frac{is - \frac{N}{2}}{\frac{N}{2}}$$

The model design for this method is described as follows.
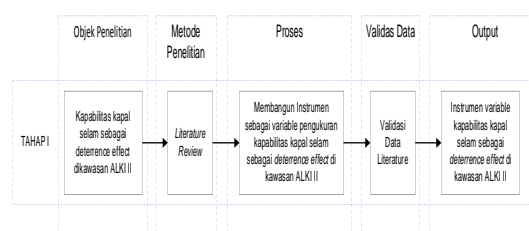
Analytical Hierarchy Process (AHP) describes complex multi-factor or multi-criteria problems into a hierarchy. According to Saaty, hierarchy is defined as a representation of a complex problem in a multi-level structure, where the first level is the goal, followed by the levels of factors, criteria, sub-criteria and so on down to the last level of alternatives with a hierarchy, a complex problem can be described in groups which are then arranged into a hierarchy as the problem will appear more systematically structured. [9]. This method uses the criteria and sub-

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[9] Giovanni Improta et al., "Use of the AHP Methodology in System Dynamics: Modelling and Simulation for Health Technology Assessments to Determine the Correct Prosthesis Choice for Hernia Diseases," *Mathematical*

criteria from the results of the CVI literature review into a hierarchy diagram.
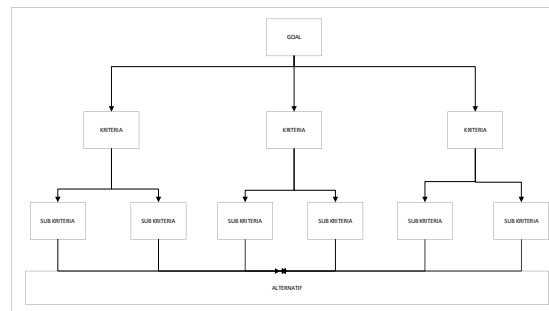
Validation of AHP results was tested using the Consistency Index (CI) and Consistency Ratio (CR) assessments.

$$CI = \frac{\lambda maks - n}{n};$$

And

$$CR = \frac{THERE}{RI}$$

If the CR ratio is 0.1 (i.e. 10%), the matrix is said to be consistent and decision W is accepted. CR on the other hand implies too many contradictions in the matrix. Anticipate the latter situation by reviewing the matrix. The results of this calculation were validated using CI/CR on the results of a questionnaire involving 7 expert personnel. The model design for this method is described as follows.
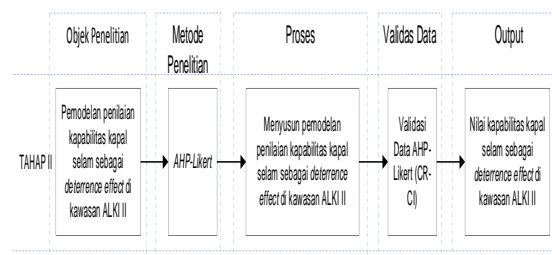
Dynamic Systems Method

Modeling is a way to solve problems that occur in real world. Modeling involves the process of mapping real world problems and modeling them into a world model (abstraction process) as well as the analysis and optimization process to obtain solutions that can be implemented in the real world.[10] In the ten years since its publication, the range of applications expanded to include research management [11]. Simulation is the operation of a system model used before changes occur to an existing system to reduce the impact of failure, eliminate unexpected obstacles, prevent excessive use of resources, and optimize system performance. [12]. any capability

Biosciences 299, no. February (2018): 19–27, https://doi.org/10.1016/j.mbs.2018.03.004.

[10] John Sterman, "System Dynamics at Sixty: The Path Forward," *System Dynamics Review* 34, no. 1–2 (2018): 5–47, https://doi.org/10.1002/sdr.1601.

[11] George P. Richardson, "Core of System Dynamics," *Encyclopedia of Complexity and Systems Science*, 2019, 1–10, https://doi.org/10.1007/978-3-642-27737-5_536-4.

[12] (Forrester, 2009)

procurement must identify and understand the underlying strategic requirements for the capability, and what will happen over the lifetime of the capability over several strategic decades that define strategic trends in Asia.[13]

The type of System Dynamics model that represents the structure of a feedback diagram can be a cause and effect diagram or what is usually called a Causative Loop Diagram (CLD). This diagram shows the direction of variable flow modification and its polarity. The flow polarity as mentioned above is divided into positive and negative. Another form of diagram that collectively depicts the structure of a system dynamics model is a flowchart. Flowcharts represent the relationships between variables created during a cause and impact diagram additionally with clear and exploitative bound symbols for various related variables.[14]
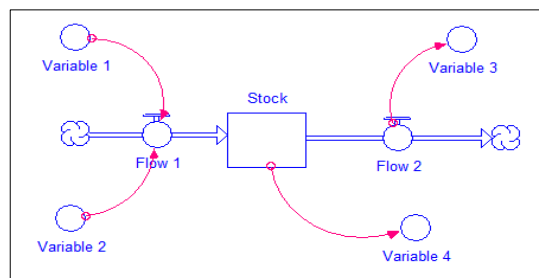
Picture 4. diagram stock flow

In this method, causal loop diagrams and stock flow diagrams are created, then the results of the AHP weighting and Likert scoring are included in the dynamic system model simulation for a 10 year time period to obtain an overview of the value of the submarine's capabilities in the next 10 year period. The model design for this method is described as follows.
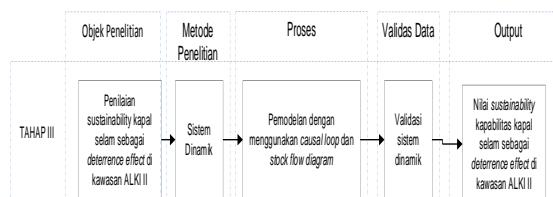
RESULTS AND DISCUSSION

Data collection was carried out in order to achieve research objectives through observation, interviews and literature study. To obtain research object data, the researcher used interview techniques and then the answers were handed back to the researcher. The next step is to test the questionnaire with a pilot test using the Aiken's V technique.[15]

The easiest process is to compare two things with reliable comparison accuracy. For this reason, quantitative scales of 1 to 9 have been established to assess the comparative level of importance of other elements. The System Dynamics Society provides a definition of how to solve complex problems that arise due to trends, reasons and the influence of various variables in a device. A submarine capability assessment model was obtained. using a literature review to determine the criteria and sub-criteria that make up submarine capability, then the criteria and sub-criteria are weighted using AHP and scoring the criteria and sub-criteria using a Likert scale,

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[13] (Kopp, n.d. 2012)
[14] (Forrester, 2010)
[15] Ricardo Monge-Rogel et al., "Design of an Instrument to Assess Students' Perception of Learning Objects in Statistics," *Education and Information Technologies* 27, no. 7 (2022): 9523–39, https://doi.org/10.1007/s10639-022-11011-w.

then entered into a dynamic system scenario to obtain a submarine capability scale for the next 10 year period come.

In this chapter, analysis and discussion and processing of data obtained during research will be discussed regarding the background using literature and the theoretical basis obtained.

Analyzed literature data

This research analyzes data obtained from literature reviews of several journals that discuss submarine capabilities which are then taken as a reference in determining criteria and sub-criteria related to assessing submarine capabilities and the influence on the deterrence effect of submarines in the ALKI II area. The results of the review of these journals are as follows:

Table 1 Submarine Capability Variable Data

NO	VARIABLE/SUB VARIABLE	SOURCE
1	Diving ability	Submarine Capabilities and Conventional Deterrence in Southeast Asia. [16]
2	Stealth capabilities	Submarine Capabilities and Conventional Deterrence in Southeast Asia. [17]
3	Attack and defense capabilities	Submarine Capabilities and Conventional Deterrence in Southeast Asia. [18]
4	Reconnaissance capabilities	Submarine Capabilities and Conventional Deterrence in Southeast Asia. [19]
5	Special operations capabilities	Submarine Capabilities and Conventional Deterrence in Southeast Asia. [20]
6	Military capability	
7	Nuclear deterrence	
8	Credible leadership	
9	Alliance and coalition	
10	Politics and law	Submarine Unit Development Strategy In Supporting The Main Tasks Of The Indonesian Navy. [21]
11	Economic factors	Submarine Unit Development Strategy In Supporting The Main Tasks Of The Indonesian Navy. [22]
12	Defense and security	Submarine Unit Development Strategy In Supporting The Main Tasks Of The Indonesian Navy. [23]
13	Environmental factor	Submarine Unit Development Strategy In Supporting The Main Tasks Of The Indonesian Navy. [24]
14	system sonar	Submarine Capabilities and Conventional Deterrence in Southeast Asia. [25]
15	Ship hull materials and construction	Submarine Capabilities and Conventional Deterrence in Southeast Asia. [26]
16	Life support system	Submarine Capabilities and Conventional Deterrence in Southeast Asia. [27]

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[16] (Andersson, 2015)

[17] (Andersson, 2015)

[18] (Andersson, 2015)

[19] (Andersson, 2015)

[20] (Andersson, 2015)

[21] Nurcahya Dwi Asmoro et al., "Submarine Unit Development Strategy in Supporting the Main" 13, no. 02 (2022): 1–11.

[22] Asmoro et al.

[23] Asmoro et al.

[24] Asmoro et al.

[25] Andersson, "Submarine Capabilities and Conventional Deterrence in Southeast Asia."

[26] Andersson.

[27] Andersson.

NO	VARIABLE/SUB VARIABLE	SOURCE
17	Logistics and maintenance support	Submarine Capabilities and Conventional Deterrence in Southeast Asia. [28]
18	Acoustic reduction system	Submarine Capabilities and Conventional Deterrence in Southeast Asia. [29]
19	Propulsion system	Submarine Capabilities and Conventional Deterrence in Southeast Asia. [30]
20	Navigation system	Submarine Capabilities and Conventional Deterrence in Southeast Asia. [31]
21	Dimensions and sizes	Submarine Capabilities and Conventional Deterrence in Southeast Asia. [32]
22	Weapon system	Submarine Capabilities and Conventional Deterrence in Southeast Asia. [33]
23	system radar	Submarine Capabilities and Conventional Deterrence in Southeast Asia. [34]
24	Communication system	Submarine Capabilities and Conventional Deterrence in Southeast Asia. [35]
25	system sensor	Submarine Capabilities and Conventional Deterrence in Southeast Asia. [36]
26	Personnel training and skills	Submarine Capabilities and Conventional Deterrence in Southeast Asia. [37]
27	Electronic jamming technology	Submarine Capabilities and Conventional Deterrence in Southeast Asia. [38]
28	Division of territorial zones	Analysis of Opportunities and Threats for Indonesian Maritime Security as an Impact of Strategic Environmental Development. [39]
29	Foreign policy	Analysis of Opportunities and Threats for Indonesian Maritime Security as an Impact of Strategic Environmental Development. [40]
30	National maritime policy	Analysis of Opportunities and Threats for Indonesian Maritime Security as an Impact of Strategic Environmental Development. [41]
31	Regional autonomy	Analysis of Opportunities and Threats for Indonesian Maritime Security as an Impact of Strategic Environmental Development. [42]
32	Economic growth of the area	Analysis of Opportunities and Threats for Indonesian Maritime Security as an Impact of Strategic Environmental Development. [43]
33	Indonesian economic growth	Analysis of Opportunities and Threats for

[28] Andersson.

[29] Andersson.

[30] Andersson.

[31] Andersson.

[32] Andersson.

[33] Andersson.

[34] Andersson.

[35] Andersson.

[36] Andersson.

[37] Andersson.

[38] Andersson.

[39] I Nengah Putra and Abdul Hakim, "Analysis of Opportunities and Threats for Indonesian Maritime Security as an Impact of Strategic Environmental Development," *Asro Jurnal-STTAL* 6 (2016): 22.

[40] Putra and Hakim.

[41] Putra and Hakim.

[42] Putra and Hakim.

[43] Putra and Hakim.

NO	VARIABLE/SUB VARIABLE	SOURCE
		Indonesian Maritime Security as an Impact of Strategic Environmental Development. [44]
34	Marine natural resources	Analysis of Opportunities and Threats for Indonesian Maritime Security as an Impact of Strategic Environmental Development. [45]
35	Defense spending budget	Analysis of Opportunities and Threats for Indonesian Maritime Security as an Impact of Strategic Environmental Development. [46]
36	Asian maritime conflicts	Analysis of Opportunities and Threats for Indonesian Maritime Security as an Impact of Strategic Environmental Development. [47]
37	Contestation of military forces in the ASIA region	Analysis of Opportunities and Threats for Indonesian Maritime Security as an Impact of Strategic Environmental Development. [48]
38	Indonesian naval strength	Analysis of Opportunities and Threats for Indonesian Maritime Security as an Impact of Strategic Environmental Development. [49]
39	Transnational crime	Analysis of Opportunities and Threats for Indonesian Maritime Security as an Impact of Strategic Environmental Developments. [50]
40	Illegal fishing	Analysis of Opportunities and Threats for Indonesian Maritime Security as an Impact of Strategic Environmental Development. [51]
41	Geographical conditions of shipping routes	Analysis of Opportunities and Threats for Indonesian Maritime Security as an Impact of Strategic Environmental Development. [52]
42	Geographical conditions of state borders	Analysis of Opportunities and Threats for Indonesian Maritime Security as an Impact of Strategic Environmental Development. [53]
43	Geographical conditions of fishing grounds	Analysis of Opportunities and Threats for Indonesian Maritime Security as an Impact of Strategic Environmental Development. [54]

The data above was then validated using the Content Validation Index (CVI) by distributing questionnaires to 15 expert personnel to provide responses and assessments of the content used to obtain the following results:

Table 2 Results of data processing I using CVI

No	SUB/SUB-SUB CRITERIA	STD	N	A	I-CVI	Is
	SUBMARINE CAPABILITY					
1	Diving Ability	0.72	15	13	0.87	Very valid
2	Sistem Sonar	0.62	15	14	0.93	Very valid
3	Ship hull materials and	0.70	15	14	0.93	Very valid

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[44] Putra and Hakim.
[45] Putra and Hakim.
[46] Putra and Hakim.
[47] Putra and Hakim.
[48] Putra and Hakim.
[49] Putra and Hakim.
[50] Putra and Hakim.
[51] Putra and Hakim.
[52] Putra and Hakim.
[53] Putra and Hakim.
[54] Putra and Hakim.

	construction					
4	Life support system	0.68	15	14	0.93	Very valid
5	Logistics and maintenance support	0.94	15	13	0.87	Very valid
6	**Stealth Ability**	**0.79**	**15**	**13**	**0.87**	**Very valid**
7	Acoustic reduction system	0.61	15	14	0.93	Very valid
8	Propulsion system	0.61	15	14	0.93	Very valid
9	Navigation system	0.72	15	13	0.87	Very valid
10	Dimensions and sizes	0.63	15	12	0.80	Valid
11	**Attack Ability**	**0.93**	**15**	**11**	**0.73**	**less valid**
12	Weapon system	0.57	15	12	0.80	Valid
13	System Radar	0.75	15	12	0.80	Valid
14	**Defense Capability**	**0.93**	**15**	**11**	**0.73**	**less valid**
15	Nuclear weapons system	0.71	15	13	0.87	Very valid
16	Nuclear Propulsion Systems	0.68	15	12	0.80	Valid
17	**Reconnaissance Capabilities**	0.88	15	12	0.80	Valid
18	Communication system	0.75	15	12	0.80	Valid
19	system sensor	0.62	15	13	0.87	Very valid
20	**Special Operations Capabilities**	**0.72**	**15**	**14**	**0.93**	**Very valid**
21	Personnel Training and Skills	0.98	15	13	0.87	Very valid
22	Electronic Jamming Technology	0.63	15	12	0.80	Valid
	DETERRENCE EFFECT					
23	**Military Capability**	**0.61**	**15**	**15**	**1.00**	**Very valid**
24	**Nuclear Deterrence**	**0.40**	**15**	**15**	**1.00**	**Very valid**
25	**Effective Communication**	**0.61**	**15**	**8**	**0.53**	**less valid**
26	**Credible Leadership**	**0.60**	**15**	**15**	**1.00**	**Very valid**
27	**Alliances and Coalitions**	**0.60**	**15**	**15**	**1.00**	**Very valid**
28	**Negotiation**	**0.47**	**15**	**5**	**0.33**	**invalid**
29	**Enemy Perceptions and Calculations**	**0.44**	**15**	**4**	**0.27**	**invalid**
30	**Economic Resources**	**0.85**	**15**	**11**	**0.73**	**less valid**
	THREAT					
31	**Politics**	**0.85**	**15**	**11**	**0.73**	**less valid**
32	Territorial Zone Division	0.62	15	13	0.87	Very valid
33	Foreign policy	0.91	15	12	0.80	Valid
34	National Maritime Policy	0.96	15	12	0.80	Valid
35	Regional autonomy	0.94	15	13	0.87	Very valid
36	**Economic factors**	**0.88**	**15**	**13**	**0.87**	**Very valid**
37	Area Economic Growth	1.02	15	12	0.80	Valid
38	Indonesian economic growth	0.75	15	15	1.00	Very valid
39	Marine Natural Resources	0.85	15	13	0.87	Very valid

No		STD	N	A		Is
40	Defense Expenditure Budget	0.93	15	12	0.80	Valid
41	**Law**	**0.81**	**15**	**11**	**0.73**	**less valid**
42	International Laws and Norms	0.77	15	11	0.73	less valid
43	**Defense and security**	0.75	15	15	1.00	Very valid
44	Asian Water Conflicts	0.62	15	15	1.00	Very valid
45	Contestation of Military Power in the ASIA Region	0.62	15	11	0.73	less valid
46	the strength of the Indonesian Navy	0.65	15	15	1.00	Very valid
47	Transnational Crime	1.00	15	11	0.73	less valid
48	Ilegal Fishing	0.85	15	15	1.00	Very valid
49	**Maritime Security**	**0.47**	**15**	**5**	**0.33**	**invalid**
50	Territorial Disputes	0.44	15	4	0.27	invalid
51	Terrorism	0.40	15	3	0.20	invalid
52	**Environmental factor**	**0.72**	**15**	**12**	**0.80**	**Valid**
53	Geographic Conditions of Shipping Routes	0.77	15	12	0.80	Valid
54	Geographical Conditions of State Borders	0.94	15	13	0.87	Very valid
55	Geographical Conditions of Fishing Grounds	0.63	15	12	0.80	Valid
				13	44.00	
			S-CVI	0.80	invalid	
			UA-CVI	0.75	invalid	

From the results of the questionnaire, data obtained that 2 money contents were declared invalid, then the contents that were declared invalid were deleted from the list of variables so that the list of variables became as follows:

Table 3 Data Processing Results After Eliminating Invalid Content

No	SUB/SUB-SUB CRITERIA	STD	N	A	I-CVI	Is
	SUBMARINE CAPABILITY					
1	**Diving Ability**	**0.61**	**15**	**14**	**0.93**	**Very valid**
2	Sistem Sonar	0.61	15	14	0.93	Very valid
3	Ship hull materials and construction	0.62	15	14	0.93	Very valid
4	Life support system	0.61	15	14	0.93	Very valid
5	Logistics and maintenance support	0.61	15	14	0.93	Very valid
6	**Stealth Ability**	**0.54**	**15**	**14**	**0.93**	**Very valid**
7	Acoustic reduction system	0.62	15	14	0.93	Very valid

No	SUB/SUB-SUB CRITERIA	STD	N	A	I-CVI	Is
8	Propulsion system	0.61	15	14	0.93	Very valid
9	Navigation system	0.61	15	14	0.93	Very valid
10	Dimensions and sizes	0.54	15	14	0.93	Very valid
11	**Attack Ability**	**0.77**	**15**	**11**	**0.73**	**less valid**
12	Weapon system	0.57	15	14	0.93	Very valid
13	System Radar	0.60	15	14	0.93	Very valid
14	**Defense Capability**	**0.77**	**15**	**11**	**0.73**	**less valid**
15	Nuclear weapons system	0.44	15	4	0.27	invalid
16	Nuclear Propulsion Systems	0.47	15	5	0.33	invalid
17	**Reconnaissance Capabilities**	0.72	15	13	0.87	Very valid
18	Communication system	0.70	15	13	0.87	Very valid
19	system sensor	0.62	15	13	0.87	Very valid
20	**Special Operations Capabilities**	**0.60**	**15**	**14**	**0.93**	**Very valid**
21	Personnel Training and Skills	0.70	15	13	0.87	Very valid
22	Electronic Jamming Technology	0.57	15	13	0.87	Very valid
	DETERRENCE EFFECT					
23	**Military Capability**	**0.68**	**15**	**13**	**0.87**	**Very valid**
24	**Nuclear Deterrence**	**0.71**	**15**	**13**	**0.87**	**Very valid**
25	**Effective Communication**	**0.47**	**15**	**5**	**0.33**	**invalid**
26	**Credible Leadership**	**0.72**	**15**	**13**	**0.87**	**Very valid**
27	**Alliances and Coalitions**	**0.70**	**15**	**13**	**0.87**	**Very valid**
28	**Economic Resources**	**0.72**	**15**	**6**	**0.40**	**invalid**
	THREAT					
29	**Politics**	**0.49**	**15**	**9**	**0.60**	**less valid**
30	Territorial Zone Division	0.68	15	13	0.87	Very valid
31	Foreign policy	0.50	15	14	0.93	Very valid
32	National Maritime Policy	0.72	15	13	0.87	Very valid
33	Regional autonomy	0.72	15	13	0.87	Very valid
34	**Economic factors**	**0.62**	**15**	**14**	**0.93**	**Very valid**
35	Area Economic Growth	0.68	15	13	0.87	Very valid
36	Indonesian economic growth	0.71	15	13	0.87	Very valid
37	Marine Natural Resources	0.60	15	14	0.93	Very valid
38	Defense Expenditure Budget	0.61	15	14	0.93	Very valid
39	**Law**	**0.81**	**15**	**9**	**0.60**	**less valid**
40	International Laws and Norms	0.47	15	5	0.33	invalid
41	**Defense and security**	0.61	15	14	0.93	Very valid
42	Asian Water Conflicts	0.62	15	14	0.93	Very valid
43	Contestation of Military Power	0.47	15	5	0.33	invalid

N o	SUB/SUB-SUB CRITERIA	ST D	N	A	I-CVI	Is
	in the ASIA Region					
44	the strength of the Indonesian Navy	0.60	15	14	0.93	Very valid
45	Transnational Crime	0.47	15	5	0.33	invalid
46	Ilegal Fishing	0.68	15	13	0.87	Very valid
47	**Environmental factor**	**0.62**	**15**	**13**	**0.87**	**Very valid**
48	Geographic Conditions of Shipping Routes	0.62	15	14	0.93	Very valid
49	Geographical Conditions of State Borders	0.62	15	14	0.93	Very valid
50	Geographical Conditions of Fishing Grounds	0.70	15	13	0.87	Very valid
				14	40.27	
			S-CVI		0.81	valid
			UA-CVI		0.78	valid

From the CVI results it was stated that the content was accepted and then the list of variables was used as criteria and sub-criteria in the research.

Analisa Hierarcy Process

The list of variables received from the CVI results is then made into an AHP hierarchical model as follows:
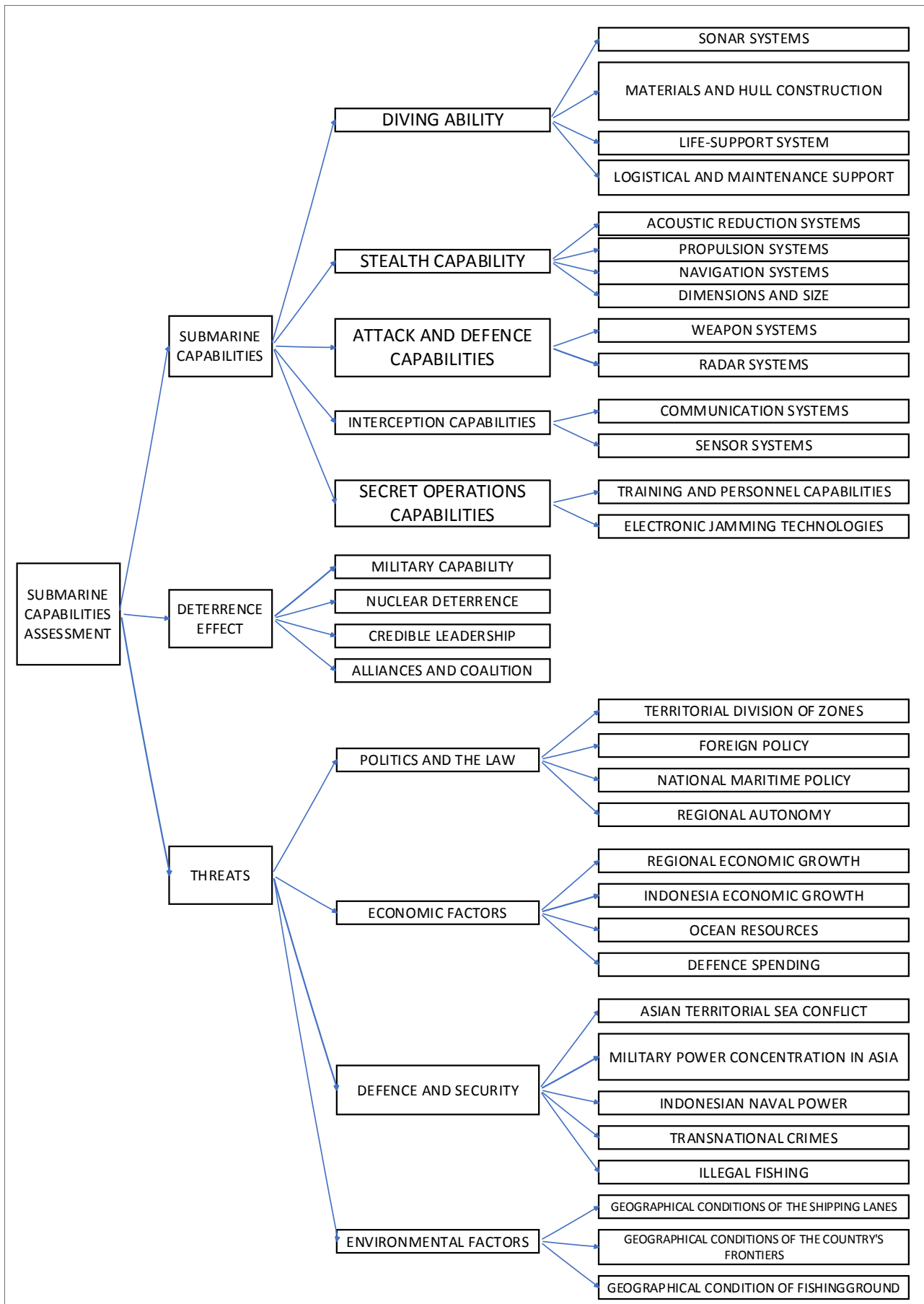
Picture 5. Submarine Capability Assessment Hierarchy Diagram

Based on the hierarchy of criteria and sub-criteria variables that make up the assessment of submarine capability and increasing the deterrence effect of submarines in the ALKI II area in Figure 4.1, an assessment of the weight of the criteria and sub-criteria is then carried out through expert assessment by distributing questionnaires so that the weight value of each criterion and sub-criteria is obtained. as presented in Figure 4.2 below:

Table 4 Pairwise Comparison of Submarine Capability Criteria.

CODE	DESCRIPTION	BOBOT (AVERAGE)
K-1	SUBMARINE CAPABILITY	
K-1.1	Diving Ability	0.31
K-1.2	Stealth Ability	0.26
K-1.3	Attack Ability	0.24
K-1.5	Reconnaissance Capabilities	0.15
K-1.6	Special Operations Capabilities	0.11

Table..5 Pairwise Comparison of Deterrence Effect Criteria.

CODE	DESCRIPTION	BOBOT (AVERAGE)
K-2	DETERRENCE EFFECT	
K-2.1	Military Capability	0.35
K-2.3	Nuclear Deterrence	0.30
K-2.4	Credible Leadership	0.20
K-2.5	Alliances and Coalitions	0.15

Table..6 Pairwise Comparison of Threat Criteria.

CODE	DESCRIPTION	BOBOT (AVERAGE)
K-3	THREAT	
K-3.1	Politics and Law	0.35
K-3.2	Economic factors	0.28
K-3.4	Defense and security	0.22
K-3.6	Environmental factor	0.15

Table..7 Pairwise Comparison of Diving Ability Sub-Criteria.

CODE	DESCRIPTION	BOBOT (AVERAGE)
K-1.1	Diving Ability	
SK-1.1.1	Sistem Sonar	0.36
SK-1.1.2	Ship hull materials and construction	0.35
SK-1.1.3	Life support system	0.29
SK-1.1.4	Logistics and maintenance support	0.13

Table..8 Pairwise Comparison of Stealth Ability Sub-Criteria.

CODE	DESCRIPTION	BOBOT (AVERAGE)
K-1.2	Stealth Ability	
SK-1.2.1	Reduction system acoustic	0.39
SK-1.2.2	Propulsion system	0.26
SK-1.2.3	Navigation system	0.18
SK-1.2.4	Dimensions and size	0.33

Table..9 Pairwise Comparison of Attack and Defense Capability Sub Criteria.

CODE	DESCRIPTION	BOBOT (AVERAGE)
K-1.3	Attack and defense capabilities	
SK-1.3.1	Weapon system	0.64
SK-1.3.2	System Radar	0.36

Table.10 Pairwise Comparison of Reconnaissance Capability Sub-Criteria.

CODE	DESCRIPTION	BOBOT (AVERAGE)
K-1.5	Reconnaissance Capabilities	
SK-1.4.1	Communication system	0.62
SK-1.4.2	system sensor	0.38

Table..11 Pairwise Comparison of Special Operations Capability Sub-Criteria.

CODE	DESCRIPTION	BOBOT (AVERAGE)
K-1.6	Special Operations Capabilities	
SK-1.5.1	Personnel Training and Skills	0.62
SK-1.5.2	Electronic Jamming Technology	0.39

Table..12 Pairwise Comparison of Political and Legal Sub-Criteria.

CODE	DESCRIPTION	BOBOT (AVERAGE)
K-3.1	Politics and Law	
SK-3.1.1	Territorial Zone Division	0.37
SK-3.1.2	Foreign policy	0.31
SK-3.1.3	National Maritime Policy	0.17
SK-3.1.4	Regional autonomy	0.16

Table..13 Pairwise Comparison of Economic Factor Sub-Criteria.

CODE	DESCRIPTION	BOBOT (AVERAGE)
K-3.2	Economic factors	
SK-3.2.1	Area Economic Growth	0.47
SK-3.2.2	Indonesian economic growth	0.25
SK-3.2.3	Marine Natural Resources	0.20
SK-3.2.4	Defense Expenditure Budget	0.15

Table..14 Pairwise Comparison of Defense and Security Capability Sub-Criteria.

CODE	DESCRIPTION	BOBOT (AVERAGE)
K-3.4	Defense and security	
SK-3.4.1	Asian Water Conflicts	0.46
SK-3.3.2	the strength of the Indonesian Navy	0.31
SK-3.4.3	Ilegal Fishing	0.23

Table..15 Pairwise Comparison of Environmental Factor Ability Sub-Criteria.

CODE	DESCRIPTION	BOBOT (AVERAGE)
K-3.6	Environmental factor	
SK-3.6.1	Geographic Conditions of Shipping Routes	0.53
SK-3.6.2	Geographical Conditions of State Borders	0.28
SK-3.6.3	Geographical Conditions of Fishing Grounds	0.19

By using AHP, the weight values for each criterion and sub-criteria are obtained, then in the next step, the score assessment for each criterion and sub-criteria is carried out.

Data analysis and assessment using Likert

In the assessment analysis using Likert, the aim is to get a value for each criterion and sub-criteria which is then used as a determining factor for the capability level value by multiplying the AHP weight with the Likert score (scor). This assessment uses a questionnaire instrument distributed to expert personnel with an assessment scale of 1-5 with the assessment results presented in table 4.17 below:

Table 16 Submarine Capability Criteria Assessment.

CODE	DESCRIPTION	SCORE (AVERAGE
K-1	SUBMARINE CAPABILITY	
K-1.1	Diving Ability	2.40
K-1.2	Stealth Ability	2.87
K-1.3	Attack Ability	3.20
K-1.5	Reconnaissance Capabilities	2.67
K-1.6	Special Operations Capabilities	2.40

Table 17 Deterrence Effect Criteria Assessment.

CODE	DESCRIPTION	SCORE (AVERAGE
K-2	DETERRENCE EFFECT	
K-2.1	Military Capability	2.40
K-2.3	Nuclear Deterrence	2.33
K-2.4	Credible Leadership	2.67
K-2.5	Alliances and Coalitions	2.40

Table 18 Threat Criteria Assessment.

K-3	THREAT	
K-3.1	Politics and Law	2.47
K-3.2	Economic factors	2.47
K-3.4	Defense and security	2.47

K-3.6	Environmental factor	2.27

Table 19 Diving Ability Sub-Criteria Assessment.

K-1.1	Diving Ability	
SK-1.1.1	Sistem Sonar	2.40
SK-1.1.2	Ship hull materials and construction	2.87
SK-1.1.3	Life support system	2.60
SK-1.1.4	Logistics and maintenance support	2.07

Table 20 Stealth Ability Sub Criteria Assessment.

K-1.2	Stealth Ability	
SK-1.2.1	Acoustic reduction system	2.53
SK-1.2.2	Propulsion system	2.47
SK-1.2.3	Navigation system	2.73
SK-1.2.4	Dimensions and sizes	2.73

Table 21 Assessment of Attack and Defense Capability Sub Criteria.

K-1.3	Attack and defense capabilities	
SK-1.3.1	Weapon system	2.33
SK-1.3.2	System Radar	2.00

Table 22 Reconnaissance Capability Sub-Criteria Assessment

K-1.5	Reconnaissance Capabilities	
SK-1.4.1	Communication system	2.40
SK-1.4.2	System sensor	2.67

Table 23 Special Operations Capability Sub-Criteria Assessment.

K-1.6	Special Operations Capabilities	
SK-1.5.1	Personnel Training and Skills	2.27
SK-1.5.2	Electronic Jamming Technology	2.60

Table 24 Political and Legal Sub-Criteria Assessment.

K-3.1	Politics and Law	
SK-3.1.1	Division of Territorial Zones	2.80
SK-3.1.2	Foreign policy	2.53
SK-3.1.3	National Maritime Policy	2.53
SK-3.1.4	Regional autonomy	2.20

Table 25 Economic Factor Sub-Criteria Assessment.

K-3.2	Economic factors	
SK-3.2.1	Area Economic Growth	2.53
SK-3.2.2	Indonesian economic growth	1.93
SK-3.2.3	Marine Natural Resources	1.87
SK-3.2.4	Defense Expenditure Budget	2.80

Table 26 Defense and Security Sub-Criteria Assessment.

K-3.4	Defense and security	
SK-3.4.1	Asian Water Conflicts	2.80
SK-3.3.2	the strength of the Indonesian Navy	2.53
SK-3.4.3	Ilegal Fishing	2.53

Table 27 Assessment of Environmental Factor Sub-Criteria.

| K-3.6	Environmental factor	
SK-3.6.1	Geographic Conditions of Shipping Routes	2.87
SK-3.6.2	Geographical Conditions of State Borders	2.20
SK-3.6.3	Geographical Conditions of Fishing Grounds	2.33

Analysis and simulation of dynamic systems
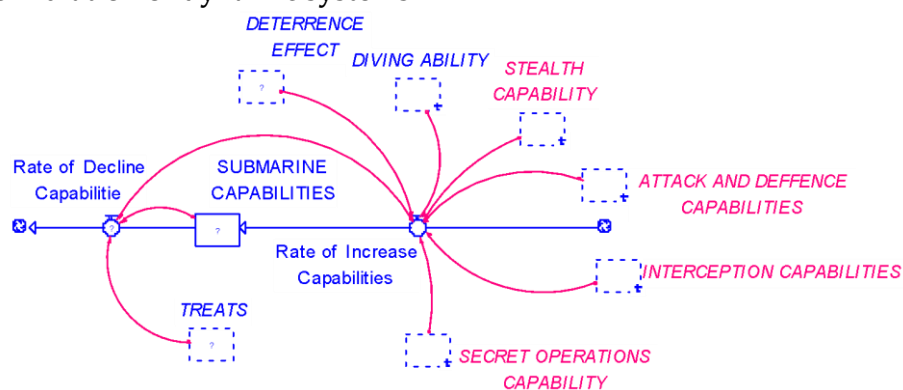
Picture **Error! No text of specified style in document.**.6

Table 28 Dynamic System Simulation of Submarine Capability Assessment in the Next 10 Year Period.

Years	Capability	Threat	Deterrence
2024	2.86	2.57	2.54
2025	2.92	1.94	2.74
2026	2.62	2.33	2.92
2027	3.03	2.42	3.04
2028	2.69	2.24	3.23
2029	3.12	2.12	3.37
2030	2.38	2.38	3.61
2031	3.23	2.18	3.77
2032	2.07	2.20	3.98
Final	3.60	2.17	4.11
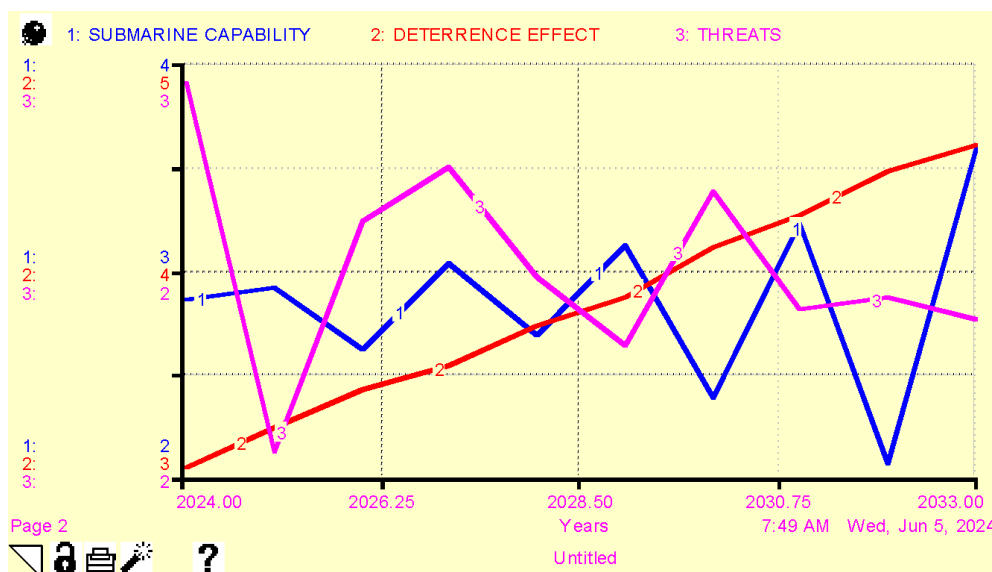
Picture 7 Dynamic System Simulation Graph for Submarine Capability Assessment in the Next 10 Year Period

Dynamic System Model sensitivity test

In the dynamic system model, a sensitivity test is carried out by carrying out changes in extreme data on several weights and values of criteria and sub-criteria for the capability of the submarine in providing a deterrence effect in the ALKI II area to determine the factors/criteria and sub-criteria that have a significant influence on the deterrence effect, in this test It is known that the factors/criteria and sub-criteria that have a significant influence are as follows:

Theoretical benefits provide a basis for capability theory in analyzing submarine capabilities as a deterrence effect. Developing sustainability assessment modeling for submarine construction as a deterrence effect in the region. The practical benefits of providing input suggestions for the Indonesian Navy, especially in the process of determining submarine construction and development policies and as material for consideration by Indonesian Navy leaders in fulfilling further policies. This research was supported by the College of Naval Technology. We also thank the personnel who have made important contributions to this research.

CONCLUSION

The instrument for measuring submarine capabilities as a deterrence effect in the ALKI II area is prepared based on 3 criteria, 13 sub-criteria and 29 sub-criteria. The criteria and sub-criteria that have a significant influence on the submarine's capability in providing a deterrence effect are

.

the submarine's capability with the sub-criteria of attack and defense capabilities. The submarine capability value of 2.86 is at level III in the medium category, meaning the submarine is able to work according to standards and is able to handle complexity, while the deterrence effect value of 2.54 is at level III in the medium level category, meaning it still has vulnerability to foreign submarine threats. . Analysis of submarine sustainability in providing a deterrence effect in the ALKI II area. The submarine capability value is 3.60 at level IV in the good level category, meaning that the submarine is able to carry out its functions according to operational standards and is able to face the complexity of threats, while the deterrence effect value is 4.11 at level V in the very high deterrence effect category so it is able to reduce the value. threat at a value of 2.17.

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