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Navy Development Strategy to Encounter Threat of National Maritime Security using SWOT- Fuzzy Multi Criteria Decision Making (F-MCDM)

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ABSTRACT

The shift of the economy from Europe to the Asia Pacific gives an impact on the traffic in the national sea region. The development of regional and Indonesia's economy has an influence on national maritime security. The Indonesia Navy (TNI AL) as a state element has a fundamental duty to maintain the security and defense of the national sea territory. Nowadays, there are several threats that occur in a national sea with an increasing trend. The paper aim is giving an analysis of Navy ability development strategy to encounter of maritime security threat. This paper uses a SWOT approach (Strength, Weakness, Opportunity, Threat), Fuzzy Multi-criteria Decision Making (FMCDM), and Borda method. The result of this paper is identified four strategies, likely Strategy 1 (SO); Strategy 2 (WO); strategy 3 (WT); Strategy 4 (ST). Strategy 1 (SO) has a weight of 0.254; Strategy 2 (WO) has a weight of 0.258; Strategy 3 (WT) has a weight of 0.214; Strategy 4 (ST) has a weight of 0.274.

1. Introduction.

Geographically, Indonesia is located between two continents and two oceans that pass 40 % of the world's sea traffic (Gindarsah, 2015), (Manurung, 2016), (Heiduk, 2016). The shift of the economy from Europe to the Asia Pacific gives an impact on the traffic in the national sea region (Espas, 2011), (Deaton & Aten, 2015). The development of regional and Indonesia's economy has an influence on national maritime security (Putra, et al., 2017).

The Indonesia Navy (TNI AL) as a state element has a fundamental duty to maintain the defense and security of the national sea territory. Nowadays, there are several threats that occur in a national sea with an increasing trend. The paper aim is giving an analysis of Navy ability development strategy to encounter of maritime security threat.

This paper uses a SWOT approach (Strength, Weakness, Opportunity, Threat), Fuzzy Multi-criteria Decision Making (FMCDM), and Borda method. SWOT analysis is used to identify internal and external factors in national maritime security, and gives alternative strategies. Fuzzy MCDM (FMCDM) method is used to select the alternative strategy in maritime security control. The Borda method is used to define the sub strategy, priorities of the selected strategy.

The inscriptive benefit of this paper is a literature for Indonesia Navy for ability development strategy. It provides academic studies for maritime security and strategic development.

To support the research, this paper has many literatures, such as literature about maritime security strategy, Chapsos and Malcolm (2017) explains about analysis of the training needs of the key player of Indonesia maritime security, which consider how the ability of maritime security in Indonesia can be improved (Chapsos & Malcolm, 2017). Zhang (2014) presents about some obstacles in maritime risk studies and to overcome uncertainty of maritime transportation (Zhang, 2014). Klimov (2015) explains about the definition of hazard and threat in maritime areas (Klimov, 2015). Bateman (2010) presents the threat effect of Asia Pacific toward maritime security in South East Asia (Bateman, 2010). Matthews (2016) presents about Indone-

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sia's response in rejecting and accepting multilateral cooperation in the Malacca Strait to establish maritime security stability (Matthews, 2016). Ramadhani (2015) presents about enhance a cooperation for all actors in the maritime sector, to reduce the likelihood of increasingly deteriorating power competition (Ramadhani, 2015). Lin and Gertner (2015) present that the maritime territory gives unique risks with different solutions on the projection of state and land-based (Lin & Gertner, 2015).

Paper literature about the method, such as Buyukozkan and Guleryuz (2016) presents about Fuzzy MCDM uses to select alternative energy with the criteria of quantitative and qualitative analysis (Buyukozkan & Guleryuz, 2016). Toklu (2017) explains about Fuzzy MCDM used to determine the level of customer loyalty (Toklu, 2017). Suharyo, et al (2017) presents about the Fuzzy MCDM to select the naval base location with factor of political, economic, and technical (Suharyo, et al., 2017). Lumaksono (2014) presents about SWOT analysis uses to obtain the weight value from the expert in identifying the internal and external factors of traditional shipbuilding industry (Lumaksono, 2014). Malik, et al (2013) explains about SWOT analysis uses to determine the external and internal factors to support of strategy formulation in business schools in the Kingdom of Saudi Arabia (Malik, et al., 2013). Shahbandarzadeh and Haghighat (2010) present that the integration results of each level and provide a final assessment of the market selection strategy (Shahbandarzadeh & Haghighat, 2010). Junior, et al (2014) presents the method to give a rank of countries in calculating the number of gold medals, silver medals and bronze medals won (Junior, et al., 2014).

The paper is organized as follows. Section 2 reviews the basic concept of method and maritime security. Section 3 gives the result and discussion of the paper. Section 4 describes the conclusion of Naval ability strategies in Indonesia.

2. Material/Methodology.

2.1. Indonesia Maritime Security.

Indonesia is the largest archipelagic country in the world with a coastline of about 81,000 km (Astor, et al., 2014). Indonesia has more than 17,000 islands and its (Akhira, et al., 2015) area covers 5.8 million km^2 or about 80% of the total area of Indonesia (Hozairi, et al., 2012). Maritime security is influenced by the actions and patterns of interaction between the actors involved. The concept of maritime security lies between two ideas: 1) groups using a traditional security framework, 2) groups using non-traditional framework (Saragih, et al., 2016).

The national security dimension relies on a traditional perspective that views national security as an effort to protect the state's sustainability. Therefore, the sea power is represented by naval force as a dominant force in the maritime. Thus, maritime security is identical with the use of naval power (Putra, et al., 2017). There are several threats to maritime security, such as; 1) threats of violence (piracy, sabotage, and vital objects of terror); 2) navigation threats; 3) the threat of resources, such as damage and pollution of the sea and its ecosystem; 4) the threat of sovereignty (Poerwowidagdo, 2015).

Table 1: Matrix of SWOT.

INTERNAL/EXTERNAL FAKTOR	STRENGTH (S) (Maximal)	WEAKNESS (W) (Minimal)
OPPORTUNITIES (O) (maximal)	S-O Strategy (Maximal-Maximal)	W-T Strategy (Minimal-Minimal)
THREATS (T) (Minimal)	S-T Strategy (Maximal-Minimal)	W-O Strategy (Minimal-Maximal)

Source: Malik, et al., 2013.

2.2. Posture of Indonesia Navy.

The development of posture is projected towards a regional maritime with an active principle that is defensive. This posture is designed to address possible threats, actual problems, and to support defense forces. There are several components in the posture, such as (Ministry of Defence, 2015):

a. Strength.

The main components of strength are built through the modernization of major weapons systems, improved maintenance, organizational development, and support of facilities and infrastructure supported by defense industries, professionalism, and welfare of soldiers.

b. Capability.

The capabilities of the Navy are designed for intelligence, diplomacy, defense, security, regional empowerment and support capabilities.

c. Deployment.

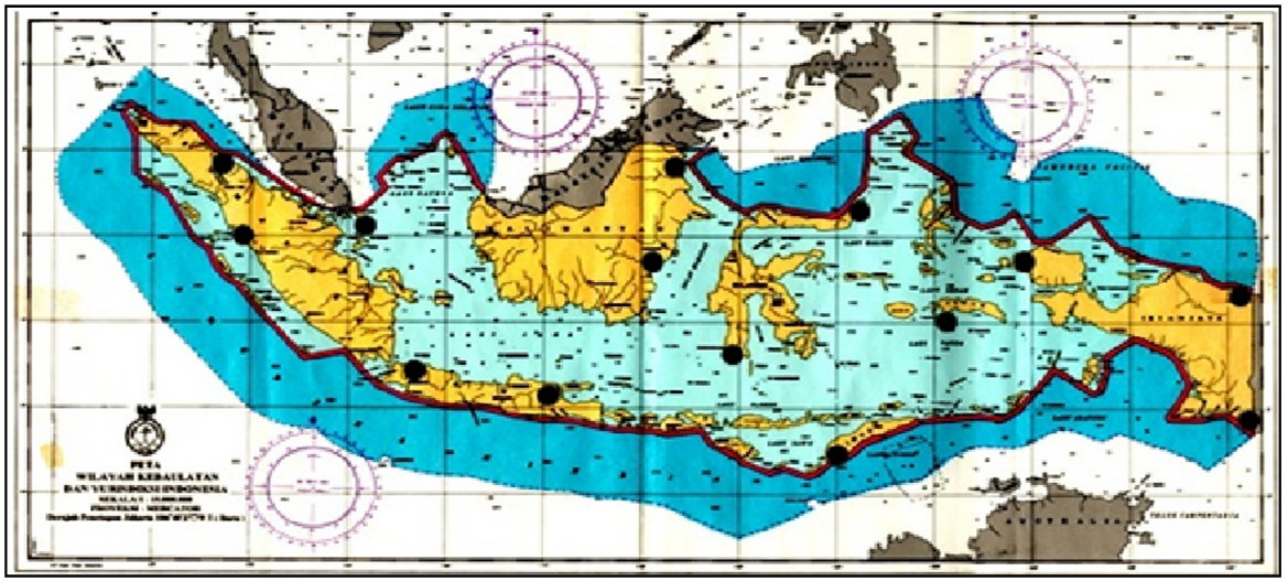
The deployment of the Navy includes organization, strength and ability. This is aligned with the establishment of a fleet command organizational structure, including centralized, territorial and support unit strength.

2.3. SWOT Analysis.

SWOT analysis is an effective strategic planning tool for analyzing the organization of internal and external influences (Leanrned, et al., 1965). SWOT analysis consists of internal and external factors. Internal factors (strengths, weaknesses) are used to test assets within an organization. External factors are used (opportunities, threats) to investigate factors in the environment beyond the organizational control that affect organizational performance (Wheelen & Hunger, 1995), (Hill & Westbrook, 1997). An information obtained can be integrated in different matrix combinations of the four factors in determining strategies for long-term progress (Yuksel & Dagdeviren, 2007).

The SWOT analysis shows the right strategy in four categories (SO, ST, WO and WT) (Lumaksono, 2014). Strength-Opportunity (SO), this strategy takes advantage of opportunities by using existing strengths. Strength-Threat (ST), this strategy uses the strength to eliminate or reduce the effects of threats. Weakness-Opportuniy (WO) strategies are used to take benefit from opportunities by external environmental factors with fixing the weaknesses. Last, Weakness-Threat (WT) strategies are used to reduce an impact from threat with fixing the (Yuksel & Dagdeviren, 2007).

Figure 1: Map of Indonesia.



Source: Authors.

2.4. Fuzzy Multi Criteria Decision Making (F-MCDM).

Liang proposes a fuzzy Multi Criteria Decision Making - (MCDM) based on ideal and anti-ideal concepts (Liang, 1999). In this section, it describes the MCDM fuzzy approach introduced by Dursun and Karsak which based on fuzzy information integration and 2-tuple linguistic representation model (Dursun & Karsak, 2010).

Table 2: Correlation Score.

Score	Strength of Corelation
1-2	Very Weak
3-4	Weak
5-6	Moderate
7-8	Strong
9-10	Very Strong

Source: Authors.

The settlement procedure used is stated as follows:

Step 1. This step shows the weighted results from a qualitative criterion level assessment to obtain aggregate weighting values.

Step 2. This step shows the result of the preference rating for each alternative based on the existing qualitative criteria.

Step 3. This stage determines the middle value of the fuzzy number. This step sums the value at each level of the linguistic scale and divides the sum with the number of criteria. Mathematical notation is as follows:

$$a_t = \frac{\sum_{i=1}^{k} \sum_j T_{ij}}{\sum_{i=1}^{k} n_{ij}} \tag{1}$$

Step 4. This step determines the lower and upper limit values of the fuzzy numbers, where the lower bound value (ct = b (i - 1)) equals the average rate down, while the upper bound value (bt = b (i - 1)) is equal to the above average level.

Step 5. This step determines the aggregate weight of each qualitative criterion. The form of linguistic assessment has a definition of fuzzy triangle number, then aggregation process is done by finding the aggregate value of the lower limit value of each (ct), mean (at) and upper limit value (bt). The equation, as follows:

$$c_t = \frac{\sum_{j=1}^{n} c_{tj}}{n}; \quad a_t = \frac{\sum_{j=1}^{n} a_{tj}}{n}; \quad b_t = \frac{\sum_{j=1}^{n} b_{tj}}{n} \tag{2}$$

Step 6. This stage calculates the preference value of each alternative based on qualitative criteria. In calculating the aggregate weight, each alternative for each criterion will show fuzzy aggregate values with the following models:

$$q_t = \frac{\sum_{j=1}^{n} q_{tj}}{n}; \quad o_t = \frac{\sum_{j=1}^{n} t_{tj}}{n}; \quad p_t = \frac{\sum_{j=1}^{n} p_{tj}}{n} \tag{3}$$

Step 7. This step calculates the fuzzy index value of each alternative appraisal result for qualitative criteria denoted by Gi. First, we get the value of Mit and Nt, to get the fuzzy match index value for each subjective criteria Gi.

$$G_i = (Y_i, Q_i, Z_i, H_{i1}, T_{i1}, H_{i2}, U_{i1}),\ i = 1,2,.....m$$

The fuzzy index values are obtained by operating each element of triangular fuzzy numbers from the numbers 2 and 4 with the following notations:

$$T_{i1} = \frac{\sum_{i=1}^{k} (o_{it} - q_{it})(a_t - c_t)}{k} \tag{4}$$

$$T_{i2} = \frac{\sum_{i=1}^{k} [q_{it}(a_t - c_t) + c_t.(o_{it} - q_{it})]}{k} \tag{5}$$

$$U_{i1} = \frac{\sum_{i=1}^{k}(p_{it} - o_{it})(b_t - a_t)}{k} \quad (6)$$

$$U_{i2} = \frac{\sum_{i=1}^{k}[b_t.(o_{it} - p_{it} + p_t.(a_t - b_t))]}{k} \quad (7)$$

$$H_{i1} = \frac{T_{i2}}{2.T_{i1}} \quad (8)$$

$$H_{i2} = -\frac{U_{i2}}{2.U_{i1}} \quad (9)$$

$$Y_i = \frac{\sum_{t=1}^{k}.q_{it}.c_t}{k} \quad (10)$$

$$Q_i = \frac{\sum_{t=1}^{k}.o_{it}.a_t}{k} \quad (11)$$

$$Z_i = \frac{\sum_{t=1}^{k}.p_{it}.b_t}{k} \quad (12)$$

Step 8. This step calculates the value of the utility in each alternative to qualitative criteria.

$$U_t(G_t) = \frac{1}{2}\left[H_{i2} - \left(H_{i2}^2 + \frac{X_R - Z_1}{U_{t1}}\right)^{\frac{1}{2}} + 1 + H_{i1}...\right]$$

$$... - \left[\left(H_{i1}^2 + \frac{X_L - Y_t}{T_{t1}}\right)^{\frac{1}{2}}\right] \quad (13)$$

$$X_R = \frac{1}{2}\left\{2x_1 + 2H_{i2}(x_2 - x_1) + \frac{(x_2 - x_1)^2}{U_{i2}}...\right\}$$

$$...\left\{-(x_2 - x_1)\left[(2H_{i2} + \frac{(x_2 - x_1)^2}{U_{i1}} + 4.\frac{x_1 - z_1}{U_{i1}})\right]^{\frac{1}{2}}\right\} \quad (14)$$

$$X_R = \frac{1}{2}\left\{2x_2 + 2H_{i1}(x_2 - x_1) + \frac{(x_2 - x_1)^2}{T_{i1}}...\right\}$$

$$...\left\{-(x_2 - x_1)\left[(2H_{i2} + \frac{(x_2 - x_1)^2}{T_{i1}} + 4.\frac{x_1 - z_1}{T_{i1}})\right]^{\frac{1}{2}}\right\} \quad (15)$$

$$ST_i = \frac{U_T.(G_i)}{\sum_{t=1}^{k} U_T.(G_i)} \quad (16)$$

Step 9. This step calculates the ranking value of each alternative based on qualitative criteria by using the following formula:

Step 10. This step Calculates the ranking value of each alternative based on quantitative criteria by the following formula:

$$OT_i = \frac{\sum_{j=1}^{p}[T_{ij}l(\sum_{i=1}^{m}.T_{ij})]}{p} \quad (17)$$

Step 11. This step Calculates the total of ranking value in each alternative to qualitative and quantitative criteria by the following formula:

$$FT_i = \frac{ST_i + OT_i}{\sum V.k}, 0 \le x \le 1 \quad (18)$$

Step 12. This step is selecting the best alternative based on the value of the highest rank.

2.5. Borda Method.

Borda Rules are included in the class of ranking rules in which points are awarded to each candidate or alternate according to rank in voter preferences (Caillaux, et al., 2011). Each decision maker must order an alternate option according to the preference specified. One point is given to the highest choice alternative; the second received two points and so on (Mohajan, 2012).

The formula describes as (Junior, et al., 2014):

Where P_a is the total number of points obtained by alternative *a* and r_{ai} is the rank of alternative *a* in Criterion *i.*

3. Results.

3.1. SWOT Analysis.

The analysis of Navy ability development strategies using SWOT (Strength, Weakness, Opportunities and Threats) is maximizing Strength and Opportunities, while minimizing Weakness and Threats. The results of the SWOT analysis are described as follows:

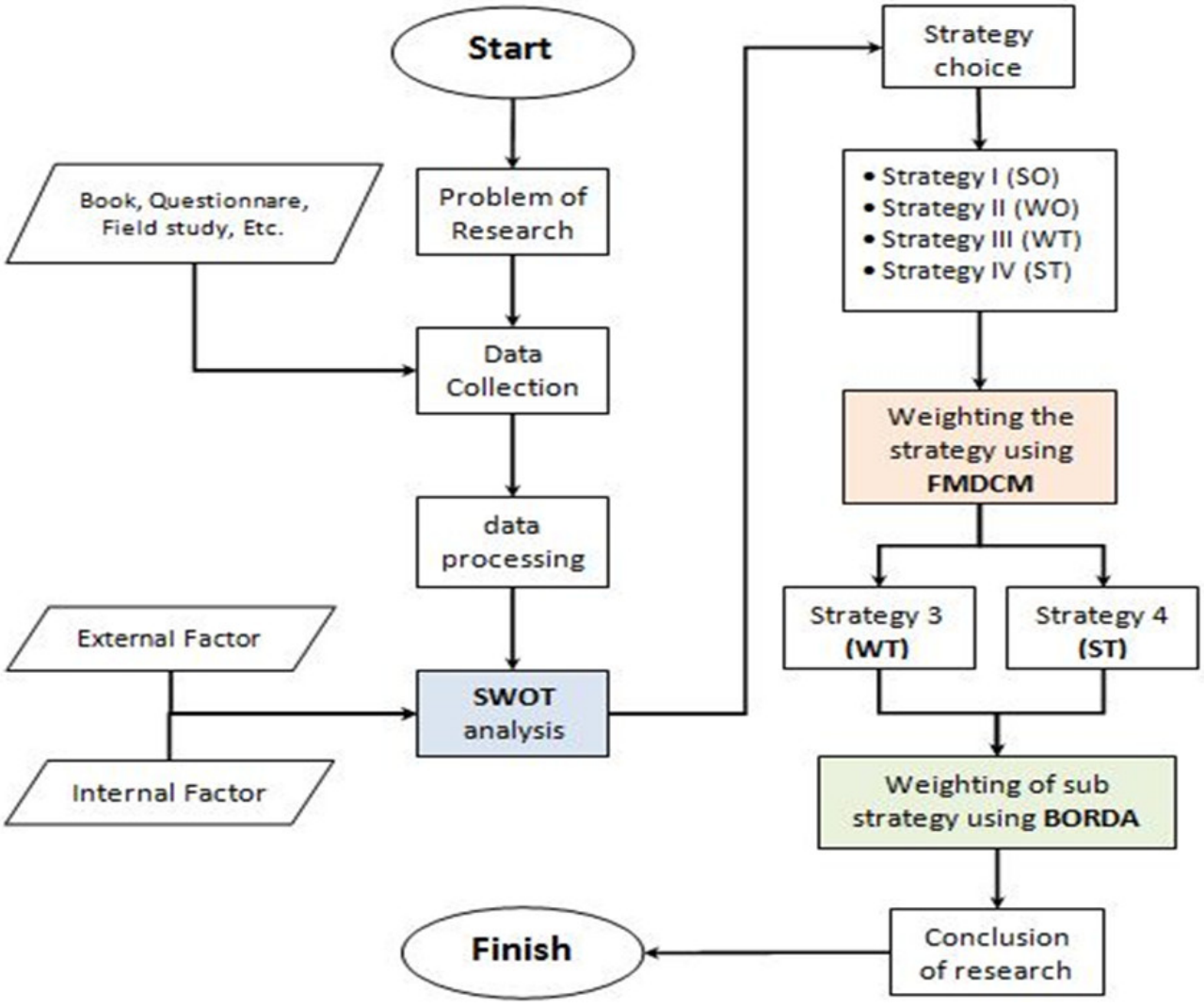
Table 3: Internal Factors from SWOT Analysis.

INTERNAL FACTOR			
STRENGTH (S)		WEAKNESS (W)	
S1	Geographical position of Indonesia between two oceans and continents.	W1	Maritime security policy that still overlap between stakeholders.
S2	Physical form and area of country.	W2	The high rate of unemployment and social inequality.
S3	Good political stability in the country	W3	Natural resources are still managed by many foreign parties.
S4	The national economic growth is quite high.	W4	The gap of educational level between regions in the border state of country.
S5	Natural marine resources both inside and on the surface are abundant.	W5	infrastructure development in regional still uneven
S6	Demographic bonus of the population with a large workforce.	W6	Vulnerable to illegal levies, abuse of authority and corruption from stakeholders.
S7	Maritime-oriented from the Government Policy	W7	Information systems are still vulnerable to attacks from cyber
S8	free-active politics from the country.	W8	Military technology still linger
S9	Character and history as a maritime nation.	W9	welfare for the crew of the Navy and other stakeholders is still limited.

Source: Authors.

Based on the results of respondents judgement, there are several internal factors that become strengths and weaknesses as contained in the table upon. It has nine points for strength analysis factor and nine points for weakness analysis factor.

Figure 2: Flowchart of Research.



Source: Authors.

Table 4: External Factors from SWOT Analysis.

EXTERNAL FACTOR			
OPPORTUNITY (O)		THREAT (T)	
O1	Indonesia has the opportunity to become the second largest maritime country in the world.	T1	Piracy
O2	As a new hegemony in Asia-pacific, a counterweight of China and US	T2	Illegal Imigrant and human trafficking
O3	The high economic growth encourages the growth of goods traffic by sea.	T3	Drug trafficking, smuggling of goods, weapons and military technology.
O4	A good national state budget encourages increased strength for the Navy capability and other	T4	The threat of terrorism both from inside and outside the country.
O5	Demographic bonus as a large market and abundant labor for the Navy and other stakeholders.	T5	Armed attacks, and violations of territorial boundaries from other countries.
O6	The growth of maritime domain awareness for the people.	T6	The threat of cyber attack.
O7	The existence of technology transfer for maritime service industry.	T7	Hunting and looting of marine resources, and illegal fishing.
O8	Utilization of marine resources for the welfare of the people.	T8	As a logistical shift path and war equipment, in case of armed conflict between other countries.
O9	Participate in the determination of world maritime security policy as a member of IMO.	T9	Threats from loss of natural resources and outer islands.

Source: Authors.

Based on table 4 upon, it has nine points for opportunity analysis factor and nine points for threat analysis factor.

From the result of SWOT analysis, it was obtained SWOT matrix which gives a description about Navy ability strategy. The strategy is contained in the SWOT matrix table below:

Based on table 5 upon, this paper given four strategies Navy ability strategies. The strategies consits of six points for strategy I Strength-opportunity (SO); six points for strategy II Weakness-Opportunity (WO); six points for strategy III Weakness-Threat (WT); six points for strategy IV Strength-Threat (ST).

3.2. Fuzzy MCDM.

The next step is to determine the strategy by the Fuzzy MCDM (F-MCDM). The choice of strategies that exists after SWOT analysis is given weight in the ranking. Previously, a questionnaire was completed by 6 competent expert assessors **(E1;E2;E3;E4;E5;E6)** in the field of navy ability.

Table 6: Questionnaire Scale for Linguistic level.

Aspect / Criteria	Very Weak		Weak		Moderate		Strong		Very Strong	
	1	2	3	4	5	6	7	8	9	10

Source: Authors.

Scale questionnaire consists of two apart, linguistic scale and a numerical scale. The example of linguistic scale is ”very weak”, ”weak”, ”moderate”, ”strong” and ”very strong”, while numerical scale interval of values take 1-10, as the table below

After obtaining the data from the questionnaire, the next step is to recapitulate the results of the questionnaire and data processing. The steps of data processing using MCDM fuzzy algorithm, as follows:

a. The result of qualitative criteria assessment from Expert judgement (E1-E6).

Table 7: Result of Qualitative Criteria Assessment.

NO	Criteria of Good Strategies	E1	E2	E3	E4	E5	E6
1	Effective communication among stakeholders.	6	8	7	7	5	7
2	The Strategy has good information about security and intelligence.	9	7	8	8	6	9
3	focus on use of national resources with effective and efficient;	6	6	9	7	7	8
4	Strategy is Supported by the ability and the number of personnel adequate.	4	9	8	8	7	9
5	The Strategy Supported by policies and funding from the Government	8	8	9	9	7	10
6	There is a good and effective interaction within the organization or between organizations.	6	7	8	5	7	6
7	There is consistency in the application of systems, processes and protocols.	5	7	6	8	7	7
8	Maritime security strategy shall synergize with risk management, quality, environment and other safety systems.	7	7	8	8	5	7
9	There are metric measurements, accurate monitoring and reporting procedures.	6	7	8	5	8	7
10	Consider the latest developments in maritime security and safety	4	7	8	8	6	7
11	There is an adequate control center.	7	6	8	8	8	6
12	Have a high sustainability	7	8	7	7	6	8

Source: Authors.

b. The result of preference assessment for each alternative based on existing qualitative criteria (Table 8).

c. Result of middle and limit value of fuzzy number (Table 9 & Table 10).

d. The result of aggregate weight of each qualitative criterion (Table 11).

e. Result of preference value of each alternative based on qualitative criteria (Table 12).

f. The result of fuzzy index value from each alternative appraisal result for qualitative criteria (Table 13 & Table 14).

g. The result of utility value in each alternative to qualitative criteria (Table 15).

h. The result of ranking value on each alternative based on the qualitative criteria (Table 16).

i. The result of ranking value from each alternative based on quantitative criteria (Table 17).

Table 17: Weighting result of Strategies.

Strategy	Fti	RANKING
S1 (SO)	0,254	III
S2 (WO)	0,258	II
S3 (WT)	0,214	IV
S4 (ST)	0,274	I

Source: Authors.

Based on Fuzzy MCDM Analysis, this paper generates the weighting of strategies available in maritime security control.

Table 5: Matrix of Strategies from SWOT.

		INTERNAL FACTORS			
		STRENGTH (S)		WEAKNESS (W)	
EXTERNAL FACTORS	OPPORTUNITY (O)	Strategy I (SO)		Strategy II (WO)	
		(SO)1	• Utilization of geographical position as the world's shipping traffic and protection for maritime activites.	(WO)1	• Establish an integrated task force with fellow stakeholders in maritime security.
		(SO)2	• Development of maritime industry and technology transfer cooperation with developed countries.	(WO)2	• Implementing re-negotiations with foreign parties in the management of marine resources.
		(SO)3	• Increase of State Budget percentage for the development of Navy ability.	(WO)3	• Development of educational infrastructure in every coastal area and the addition of teacher quota.
		(SO)4	• Rebuild culture as a maritime nation.	(WO)4	• Establish a task force to eradicate corruption and illegal levies on marine sector.
		(SO)5	•Utilization of the abundant labor force in recruitment of Navy combat personnel.	(WO)5	• Cooperation with developed countries with technology transfer for military infrastructure development.
		(SO)6	• The use of the country's active-free politics as a mediator for China and US hegemony in Asia Pacific.	(WO)6	• Build a strong foundation of information systems in maritime areas.
		Strategy IV (ST)		Strategy III (WT)	
	THREATH (T)	(ST)1	• Utilization of geographical position as the world's shipping traffic and protection for maritime activites.	(WT)1	• Establish an integrated task force with fellow stakeholders in maritime security.
		(ST)2	• Increase of State Budget percentage for the development of Navy ability.	(WT)2	• Equitable development of maritime base infrastructure and connectivity, especially in coastal and border areas.
		(ST)3	• Equitable development of maritime base infrastructure and connectivity, especially in coastal and border areas.	(WT)3	• Cooperation with friendly countries to the handling of transnational crime.
		(ST)4	• Negotiations with neighboring countries in trans-state sea border agreements.	(WT)4	• Empowerment of the maritime industry in coastal areas, for the opening of employment in each region as a consequence of demographic bonus.
		(ST)5	• The use of the country's active-free politics as a mediator for China and US hegemony in Asia Pacific.	(WT)5	• Strict action of any criminal offenses at sea.
		(ST)6	• Build a strong foundation and infrastructure of information systems prevent cyber attacks.	(WT)6	• Build a strong foundation and infrastructure of information systems prevent cyber attacks.

Source: Authors.

Table 8: Result of Preference Assessment.

NO	CRITERIA	Strategies	E 1	E 2	E 3	E 4	E 5	E 6
1	Effective communication among stakeholders.	S1 (SO)	6	6	9	8	7	9
		S2 (WO)	9	8	7	9	9	9
		S3 (WT)	8	7	9	9	9	8
		S4 (ST)	8	6	6	8	9	6
2	The Strategy has good information about security and intelligence.	S1 (SO)	6	6	7	6	8	7
		S2 (WO)	8	7	9	8	7	9
		S3 (WT)	6	7	4	7	6	6
		S4 (ST)	9	9	7	7	9	9
3	focus on use of national resources with effective and efficient;	S1 (SO)	8	9	8	7	9	8
		S2 (WO)	6	7	7	6	8	9
		S3 (WT)	7	6	7	6	8	7
		S4 (ST)	7	5	7	8	8	7
4	Strategy is Supported by the ability and the number of personnel adequate.	S1 (SO)	8	8	9	9	7	8
		S2 (WO)	6	7	5	6	5	6
		S3 (WT)	6	7	8	6	8	7
		S4 (ST)	6	8	7	6	6	7
5	The Strategy Supported by policies and funding from the Government	S1 (SO)	8	8	9	8	9	9
		S2 (WO)	8	7	7	7	8	8
		S3 (WT)	6	8	7	6	8	7
		S4 (ST)	9	7	7	7	8	9
6	There is a good and effective interaction within the organization or between organizations.	S1 (SO)	6	8	8	6	7	7
		S2 (WO)	7	8	6	6	8	9
		S3 (WT)	7	9	8	8	6	6
		S4 (ST)	8	8	7	8	6	8
7	There is consistency in the application of systems, processes and protocols.	S1 (SO)	8	8	7	7	6	6
		S2 (WO)	6	5	5	6	9	6
		S3 (WT)	6	8	7	6	6	5
		S4 (ST)	6	6	7	8	7	7
8	Maritime security strategy shall synergize with risk management, quality, environment and other safety systems.	S1 (SO)	8	8	7	8	9	7
		S2 (WO)	6	7	7	6	8	9
		S3 (WT)	6	6	8	5	5	8
		S4 (ST)	8	8	7	8	9	8
9	There are metric measurements, accurate monitoring and reporting procedures.	S1 (SO)	6	6	8	5	7	6
		S2 (WO)	7	6	8	8	6	6
		S3 (WT)	6	8	7	7	6	6
		S4 (ST)	8	7	7	6	8	8
10	Consider the latest developments in maritime security and safety	S1 (SO)	6	8	7	8	6	7
		S2 (WO)	8	7	7	8	6	7
		S3 (WT)	8	6	7	9	8	6
		S4 (ST)	7	8	9	8	8	9
11	There is an adequate control center.	S1 (SO)	6	8	6	7	8	6
		S2 (WO)	8	7	9	8	6	8
		S3 (WT)	8	8	9	6	6	7
		S4 (ST)	7	8	8	6	8	8
12	Have a high sustainability	S1 (SO)	7	6	7	8	8	6
		S2 (WO)	8	7	9	7	6	7
		S3 (WT)	7	8	8	6	7	7
		S4 (ST)	7	7	8	6	7	8

Source: Authors.

Table 9: Result of middle value.

NO	LINGUISTIC LEVEL	E1			E2			E3			E4			E 5			E6		
		ct	at	bt	ct	at	bt	ct	at	bt	ct	at	bt	ct	at	bt	ct	at	bt
1	VERY WEAK																		
2	WEAK																		
3	MODERATE	1	4	5,6667	1	6	7,333	1	6	7,75	1	5	7,67	1	5,6	7,29	1	5,5	7,286
4	STRONG	4	5,66667	7	6	7,3333	9	6	7,75	9	5	7,667	9	5,6	7,286	9	5,5	7,286	9,333
5	VERY STRONG	7	9	10	7,3333	9	10	7,75	9	10	7,66667	9	10	7,286	9	10	7,286	9,333	10,000

Source: Authors.

Table 10: Result of limit value.

NO	LINGUISTIC LEVEL	E1			E2			E3			E4			E 5			E6		
		qit	oit	pit	qit	oit	pit	qit	oit	pit	qit	oit	pit	qit	oit	pit	qit	oit	pit
1	VERY WEAK																		
2	WEAK																		
3	MODERATE	1	6	7,6296	1	5,8333	7,576	4	5,6	7,303	1	5,895	7,64	1	5,867	7,67	1	5,923	7,44
4	STRONG	6	7,62963	9	5,8333	7,5758	9	5,6	7,303	9	5,89474	7,64	9	5,867	7,667	9	5,923	7,44	9
5	VERY STRONG	7,62963	9	10	7,5758	9	10	7,303	9	10	7,64	9	10	7,667	9	10	7,44	9	10

Source: Authors.

Table 11: Result of aggregate weight.

NO	Criteria of Good Strategies	AVERAGE		
		ct	at	bt
1	Effective communication among stakeholders.	6,68	7,99	9,17
2	The Strategy has good information about security and intelligence.	3,25	6,38	7,94
3	focus on use of national resources with effective and efficient;	5,79	7,89	8,89
4	Strategy is Supported by the ability and the number of personnel adequate.	3,68	6,65	8,24
5	The Strategy Supported by policies and funding from the Government	4,18	6,44	8,28
6	There is a good and effective interaction within the organization or between organizations.	2,58	5,94	7,71
7	There is consistency in the application of systems, processes and protocols.	2,92	6,37	7,95
8	Maritime security strategy shall synergize with risk management, quality, environment and other safety systems.	3,42	6,16	7,99
9	There are metric measurements, accurate monitoring and reporting procedures.	7,39	9,06	10,00
10	Consider the latest developments in maritime security and safety	7,39	9,06	10,00
11	There is an adequate control center.	1,67	5,79	7,39
12	Have a high sustainability	3,77	6,66	8,16

Source: Authors.

Table 12: Result of preference value.

NO	Criteria of Good Strategies	Strategy	AVERAGE			NO	Criteria of Good Strategies	Strategy	AVERAGE		
			qit	oit	pit				qit	oit	pit
1	Effective communication among stakeholders.	S1 (SO)	6,137	7,83	9,167	7	There is consistency in the application of systems, processes and protocols.	S1 (SO)	3,136	6,397	8,029
		S2 (WO)	6,153	7,76	9,167			S2 (WO)	5,886	7,481	8,884
		S3 (WT)	4,227	7	8,503			S3 (WT)	6,434	8,007	9,333
		S4 (ST)	7,006	8,46	9,667			S4 (ST)	4,232	6,961	8,536
2	The Strategy has good information about security and intelligence.	S1 (SO)	3,403	6,68	8,312	8	Maritime security strategy shall synergize with risk management, quality, environment and other safety systems.	S1 (SO)	4,499	7,198	8,716
		S2 (WO)	3,942	6,69	8,267			S2 (WO)	4,221	6,99	8,518
		S3 (WT)	6,137	7,83	9,167			S3 (WT)	5,853	7,543	9
		S4 (ST)	4,221	6,97	7,218			S4 (ST)	4,195	6,947	8,433
3	focus on use of national resources with effective and efficient;	S1 (SO)	2,311	6,15	7,765	9	There are metric measurements, accurate monitoring and reporting procedures.	S1 (SO)	6,106	7,803	9,167
		S2 (WO)	2,587	6,39	8,085			S2 (WO)	3,942	6,687	8,267
		S3 (WT)	7,543	9	10			S3 (WT)	6,406	8,025	9,333
		S4 (ST)	1,5	5,85	7,543			S4 (ST)	5,042	7,243	8,778
4	Strategy is Supported by the ability and the number of personnel adequate.	S1 (SO)	4,781	6,97	8,48	10	Consider the latest developments in maritime security and safety	S1 (SO)	5,02	7,271	8,772
		S2 (WO)	6,397	8,03	9,333			S2 (WO)	6,396	8,04	9,333
		S3 (WT)	5,853	7,54	9			S3 (WT)	7,543	9	10
		S4 (ST)	5,853	7,54	9			S4 (ST)	6,153	7,765	9,167
5	The Strategy Supported by policies and funding from the Government	S1 (SO)	4,204	6,98	8,545	11	There is an adequate control center.	S1 (SO)	3,97	6,668	8,258
		S2 (WO)	5,29	7,51	8,94			S2 (WO)	5,037	7,252	8,773
		S3 (WT)	6,415	8	9,333			S3 (WT)	5,032	7,29	8,74
		S4 (ST)	5,028	7,22	8,662			S4 (ST)	7,006	8,457	9,667
6	There is a good and effective interaction within the organization or between organizations.	S1 (SO)	3,421	6,66	8,314	12	Have a high sustainability	S1 (SO)	4,766	7,006	8,457
		S2 (WO)	5,839	7,52	8,884			S2 (WO)	5,032	7,29	8,74
		S3 (WT)	6,106	7,8	9,167			S3 (WT)	4,766	7,006	8,457
		S4 (ST)	3,411	6,71	8,276			S4 (ST)	5,032	7,29	8,74

Source: Authors.

Table 13: Result of fuzzy index value.

CRITERIA NUMBER												
Yi	1	2	3	4	5	6	7	8	9	10	11	AVG
S1 (SO)	40,9941	11,06	13,392	17,609	17,59	8,836	9,148	15,37	45,1029	37,08	6,62	20,25
S2 (WO)	41,102	12,811	14,991	23,561	22,13	15,08	17,17	14,42	29,1181	47,25	8,4	22,37
S3 (WT)	28,2358	19,945	43,705	21,558	26,84	15,77	18,77	20	47,319	55,72	8,39	27,84
S4 (ST)	46,7993	13,719	8,6917	21,558	21,03	8,812	12,34	14,33	37,2437	45,45	11,7	21,97
Qi	1	2	3	4	5	6	7	8	9	10	11	AVG
S1 (SO)	49,0458	42,647	48,528	46,345	44,97	39,56	40,75	44,35	70,6561	65,84	38,6	48,3
S2 (WO)	49,1749	42,688	50,394	53,4	48,39	44,66	47,65	43,07	60,5551	72,81	42	50,44
S3 (WT)	33,7817	49,955	70,982	50,164	51,52	46,34	51	46,47	72,6684	81,5	42,2	54,24
S4 (ST)	55,9912	44,481	46,162	50,164	46,51	39,84	44,34	42,8	65,585	70,31	49	50,47
Zi	1	2	3	4	5	6	7	8	9	10	11	AVG
S1 (SO)	84,0278	65,968	69,02	69,841	70,73	64,13	63,84	69,66	91,6667	87,72	61	72,51
S2 (WO)	84,0278	65,608	71,87	76,87	74	68,53	70,63	68,07	82,6655	93,33	64,8	74,58
S3 (WT)	77,9407	72,751	88,889	74,125	77,26	70,71	74,2	71,93	93,3333	100	64,6	78,7
S4 (ST)	88,6111	57,286	67,045	74,125	71,7	63,84	67,86	67,4	87,7778	91,67	71,4	73,52
Ti1	1	2	3	4	5	6	7	8	9	10	11	AVG
S1 (SO)	2,21541	10,271	8,0389	8,2382	6,272	10,88	11,26	7,406	2,83124	3,757	11,1	7,482
S2 (WO)	2,11469	8,6028	7,9565	6,5926	5,019	5,636	5,506	7,599	4,5808	2,743	9,14	5,954
S3 (WT)	3,63746	5,2914	3,0497	4,6949	3,574	5,694	5,429	4,638	2,70146	2,432	9,32	4,587
S4 (ST)	1,90417	8,6066	9,1084	6,5007	4,949	11,07	9,426	7,555	3,67213	2,689	5,99	6,497
Ti2	1	2	3	4	5	6	7	8	9	10	11	AVG
S1 (SO)	19,3312	21,316	27,097	22,244	21,11	19,85	20,34	21,57	22,722	25,01	20,9	21,95
S2 (WO)	18,8395	21,275	27,447	24,995	21,24	23,93	24,98	21,05	26,8562	22,81	24,5	23,45
S3 (WT)	24,0655	24,719	24,228	23,592	21,11	24,87	26,8	21,84	22,648	23,35	24,5	23,8
S4 (ST)	18,8867	22,155	28,362	23,592	20,52	19,97	22,57	20,92	24,6691	22,17	31,3	23,2
Ui1	1	2	3	4	5	6	7	8	9	10	11	AVG
S1 (SO)	1,57552	2,5334	1,615	2,3962	2,872	2,933	2,58	2,78	1,28837	1,417	2,53	2,229
S2 (WO)	1,64671	2,4526	1,6991	2,0675	2,621	2,423	2,217	2,797	1,49173	1,222	2,42	2,097
S3 (WT)	1,76582	2,0828	1,002	2,3106	2,452	2,421	2,097	2,668	1,2359	0,944	2,31	1,935
S4 (ST)	1,42068	0,3886	1,6929	2,3106	2,648	2,782	2,489	2,72	1,44997	1,324	1,93	1,923
Ui2	1	2	3	4	5	6	7	8	9	10	11	AVG
S1 (SO)	-23,063	-25,855	-22,11	-25,89	-28,6	-27,5	-25,7	-28,09	-22,2989	-23,3	-24,9	-25,21
S2 (WO)	-23,618	-25,372	-23,17	-25,54	-28,2	-26,3	-25,2	-27,8	-23,6021	-21,7	-25,2	-25,07
S3 (WT)	-23,768	-24,879	-18,91	-26,27	-28,2	-26,8	-25,3	-28,12	-21,9008	-19,4	-24,6	-24,38
S4 (ST)	-22,442	-13,195	-22,58	-26,27	-27,8	-26,8	-26	-27,31	-23,6428	-22,7	-24,3	-23,92
Hi1	1	Hi2	1									
S1 (SO)	1,46696	S1 (SO)	5,6541									
S2 (WO)	1,96905	S2 (WO)	5,9795									
S3 (WT)	2,59382	S3 (WT)	6,2992									
S4 (ST)	1,78511	S4 (ST)	6,2185									

Source: Authors.

Table 14: Result of fuzzy index value.

Strategy	FUZZY INDEX								
	Yi	Qi	Zi	Hi1	Ti1	Hi2	Ui1	Ti2	Ui2
S1 (SO)	20,25	48,3	72,51	1,47	7,48	5,65	2,23	21,952	-25
S2 (WO)	22,37	50,44	74,58	1,97	5,95	5,98	2,1	23,447	-25
S3 (WT)	27,84	54,24	78,7	2,59	4,59	6,3	1,94	23,797	-24
S4 (ST)	21,97	50,47	73,52	1,79	6,5	6,22	1,92	23,196	-24

Source: Authors.

Table 15: Result of utility value.

UTILITY VALUE OF ANY ALTERNATIVE STRATEGIES							
XR - S1(SO)	134,732	14,377	191,759	-66,663	11,185	63,319	42,895
- S2(WO)	138,417	15,287	214,896	-71,024	11,995	67,905	42,900
-S3(WT)	142,037	16,560	240,982	-77,882	12,771	72,300	43,148
- S4(ST)	141,123	16,666	236,576	-76,128	12,667	71,710	43,040
XL - S1(SO)	98,646	4,284	145,561	9,211	12,441	70,430	16,250
- S2(WO)	104,331	5,383	166,666	11,227	13,338	75,508	17,103
-S3(WT)	111,405	6,987	191,340	13,674	14,318	81,059	18,666
- S4(ST)	102,248	4,933	177,114	10,452	13,695	77,533	14,824
Ut(Gt) - S1(SO)	4,323	3,798	1,272	1,263			
- S2(WO)	4,543	4,405	1,730	1,338			
-S3(WT)	4,616	5,277	2,174	0,988			
- S4(ST)	4,777	4,227	1,445	1,391	4,980		

Source: Authors.

Table 16: Result of ranking value.

NO	CRITERIA OF STRATEGIES	DEFUZZIFICATION CRITERIA	DEFUZZIFICATION OF ALTERNATIVE STRATEGIES				MULTIPLICATION VALUE OF DEFUZZY (CRITERIA*ALT)			
			S1 (SO)	S2 (WO)	S3 (WT)	S4 (ST)	S1 (SO)	S2 (WO)	S3 (WT)	S4 (ST)
1	Effective communication among sta	7,946	7,710	7,695	6,576	8,377	61,262	61,145	52,257	66,562
2	The Strategy has good information	5,857	6,132	6,298	7,710	6,136	35,913	36,889	45,153	35,935
3	focus on use of national resources	7,523	5,410	5,687	8,848	4,965	40,699	42,789	66,563	37,355
4	Strategy is Supported by the ability	6,190	6,743	7,920	7,465	7,465	41,739	49,024	46,210	46,210
5	The Strategy Supported by policies	6,301	6,576	7,247	7,915	6,969	41,438	45,666	49,877	43,916
6	There is a good and effective inter	5,412	6,132	7,414	7,692	6,132	33,187	40,126	41,630	33,187
7	There is consistency in the applica	5,746	5,854	7,417	7,925	6,576	33,635	42,615	45,533	37,785
8	Maritime security strategy shall sy	5,857	6,804	6,576	7,465	6,525	39,851	38,516	43,722	38,215
9	There are metric measurements, a	8,814	7,692	6,298	7,921	7,021	67,795	55,516	69,819	61,882
10	Consider the latest developments	8,814	7,021	7,923	8,848	7,695	61,882	69,836	77,983	67,823
11	There is an adequate control cente	4,949	6,298	7,021	7,021	8,377	31,173	34,748	34,748	41,458
12	Have a high sustainability	6,196	6,743	7,021	6,743	7,021	41,777	43,498	41,777	43,498
						AVERAGE VALUE OF DEFUZZY	35,357	37,358	41,018	36,922

Source: Authors.

Strategy 1 (SO) has a weight of 0.254; Strategy 2 (WO) has a weight of 0.258; Strategy 3 (WT) has a weight of 0.214; Strategy 4 (ST) has a weight of 0.274.

4. Discussion.

4.1. Strategies Development based on Threat.

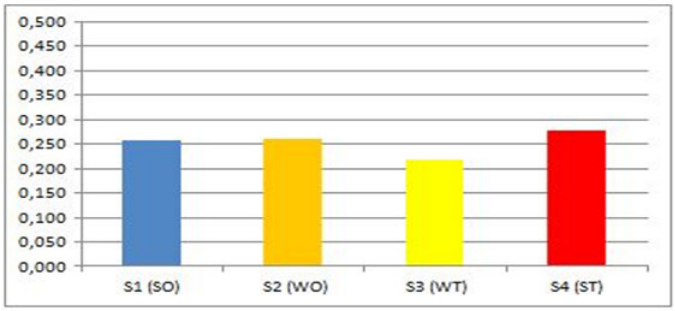
In this research, Borda method is used to provide priority allocation scale to existing sub-strategy and budget allocation in rank strategy of previous Fuzzy MCDM analysis.

Table 18: Weight result of sub-strategy IV.

Code	Strategy	%	Weight
	Strategy IV (S-T)	Percent	0,274
(ST)1	Increase the percentage of State Budget for maritime sector in the development of force of Navy and other stake holder to carry out the operation of sea crime	25,24	0,069
(ST)2	Development of maritime infrastructure and connectivity in coastal and border areas to open	23,33	0,064
(ST)3	Rebuild culture as a maritime nation.	10,95	0,030
(ST)4	Conducting negotiations with related neighboring countries in handling sea border country transfers	22,86	0,063
(ST)5	The development of shipping academy infrastructure in every coastal area and the addition of teacher.	7,62	0,021
(ST)6	Carry out re-negotiations with foreign parties in the management of natural resources controlled by	10,00	0,027

Source: Authors.

Figure 3: Graph of Weighting result of Strategies.

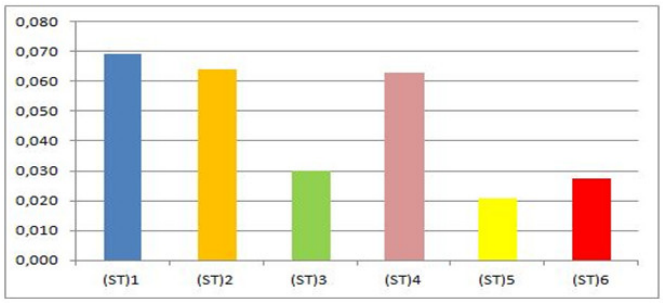


Source: Authors.

4.2. S-T Strategy.

Based on table 18 upon, the sub strategies were weighted. (ST)1 has a weight of 0,069; (ST)2 has a weight of 0,064; (ST)3 with a weight of 0,03; (ST)4 with a weight of 0,063; (ST)5 with a weight of 0,021; (ST)6 has a weight of 0,027.

Figure 4: Graph of sub-strategy IV.



Source: Authors.

4.3. W-T Strategy.

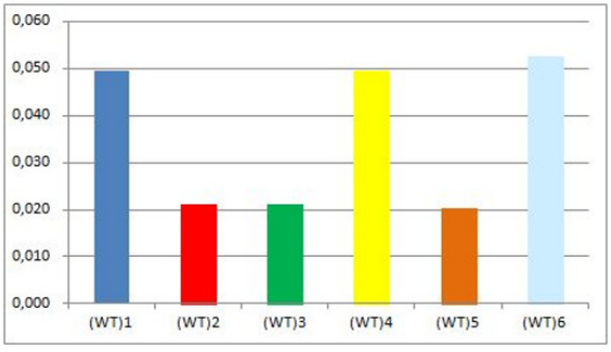
Based on table 18 upon, the sub strategies were weighted. (WT)1 has a weight of 0,05 as a first priority; (WT)2 has a weight of 0,021; (WT)3 with a weight of 0,021; (WT)4 with a weight of 0,05; (WT)5 with a weight of 0,02; (WT)6 has a weight of 0,053.

Table 19: Weight result of sub-strategy III.

Code	Strategy	%	Weight
	Strategy III (W-T)	Percent	0,214
(WT)1	Establish an integrated task force with fellow stakeholders in maritime security.	23,11	0,050
(WT)2	Equitable development of maritime base infrastructure and connectivity, especially in coastal and border areas.	9,91	0,021
(WT)3	Cooperation with friendly countries to the handling of	9,91	0,021
(WT)4	Empowerment of the maritime industry in coastal areas, for the opening of employment in each region as a consequence of	23,11	0,050
(WT)5	Strict action of any criminal offenses at sea.	9,43	0,020
(WT)6	Build a strong foundation and infrastructure of information systems prevent cyber attacks.	24,53	0,053

Source: Authors.

Figure 5: Graph of sub-strategy III.



Source: Authors.

Conclusions.

The shift of the economy from Europe to the Asia Pacific gives an impact on the traffic in the national sea region. On the other side, the development of regional and Indonesia's economy has an influence on national maritime security. The result

of this paper is identified four strategies, likely Strategy 1 (SO); Strategy 2 (WO); strategy 3 (WT); Strategy 4 (ST). Strategy 1 (SO) has a weight of 0.254; Strategy 2 (WO) has a weight of 0.258; Strategy 3 (WT) has a weight of 0.214; Strategy 4 (ST) has a weight of 0.274. The result of strategy development based on threat, such as strategy 4 (ST) has six sub strategies with a weight 0,069 for (ST)1; 0,064 for (ST)2; 0,03 for (ST)3; 0,063 for (ST)4; 0,021 for (ST)5; 0,027 for (ST)6. Strategy 3 (WT) has six sub strategies with a weight 0,05 for (WT)1; 0,021 for (WT)2; 0,021 for (WT)3; 0,05 for (WT)4; 0,02 for (WT)5; 0,053 for (WT)6.

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