The Urgency Of Autonomous Vehicle-Based Patrol Systems In The North Natuna Sea Maritime Border

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ABSTRACT
Patrolling in the North Natuna Sea border area is crucial for every country. Limitations in patrols can create opportunities for foreign entities to be present in the Indonesian region as a sovereign state. Various issues occurring in the government's ability to allocate logistics (especially fuel) are of utmost concern. Based on this, it is necessary to prepare alternative solutions that minimize fuel usage but can be optimal in border monitoring, one of which is the use of autonomous vehicles. This research uses a mixed-method research method with a sequential exploratory design to test the urgency of autonomous vehicles intended to guard the border area. The results of the study show that the urgency of using autonomous vehicles to guard the border areas in the North Natuna Sea is crucial, as evidenced by the quadrant value in quadrant I with a matrix IFEM value of 1.54 and an EFEM matrix value of 2.66. The urgency can be seen from a combination of various strategic factors that have been outlined, including the SO, WO, ST, and WT strategies.

Keywords: Natuna, SO, WO, ST, crucial, country.

INTRODUCTION
Depending on Navy Hydro-Oceanography Center of the Indonesian Navy, Indonesia comprises 17,504 islands with a coastline stretching over 108,000 km^2 and is surrounded by vast waters reaching 6,400,000 km^2. Therefore, Indonesia, as an archipelagic nation with 2/3 of its territory being maritime, is one of the tropical regions endowed with high natural support capabilities and mega-biodiversity. Conflict South China Sea is a new road for obtaining natural resource, where some countries have conflicting claim over the border, (Sobar Wirasuta, 2015). This condition undoubtedly attracts the interest of other countries or stakeholders, leading them to attempt legal or illegal management, which, in its utilization, can be detrimental and harmful to Indonesia's marine environment (Prasetyo et al., 2019). Border threat issues have indeed become a central topic for discussion, this is in line with data released by Indonesian Navy Staff of Operations, Fleet Command I in 2023, indicating that there were 162 violations of maritime border areas from 2019 to 2022, indicating the North Natuna Sea is full of illegal fishing and endangers Indonesia's maritime security, (Prakoso & Pertahanan, 2020), (Aditya Dewantara et al., 2021). Among all violations, China, through its Coast Guard, played a dominant role in escorting fishing vessels, and theft by Vietnamese fishing vessels was a prevalent incident (Indonesian Navy Staff of Operations, Fleet Command I, 2023).
The doctrine "Si Vis Pacem Para Bellum," which translates to "If you want peace, prepare for war," becomes increasingly relevant in the face of the dynamics of the global and regional strategic environment that affect the defense system that Indonesia must prepare, (Fathun et al., 2023). China's aggressive actions in the Natuna Sea serve as evidence that maritime defense in Indonesia remains a serious concern that needs to be addressed. The Indonesian Navy (TNI AL) has carried out the sea combat alert operation and the North Natuna Sea Security Operation, involving various types of Republic of Indonesia Warships (KRI), helicopters, and aircraft such as the Casa 212 Palmar (Indonesian Navy Staff of Operations, Fleet Command I, 2023). To harness the increasingly vast and diverse natural resources and defend the territorial integrity and rights of the Republic of Indonesia (NKRI) at sea, an enhancement of the capabilities in enforcing national defense needs to be considered, (Djalal & Kelautan Indonesia, 2015). The operations conducted are in accordance with the provisions of the Indonesian Minister of Defense Regulation Number 13 of 2014 concerning Border Security Policy, specifically in articles 3, 4, and 5, which emphasize the integration of air control systems, surveillance, and early warning for the prevention of

sovereignty infringement, territorial violations, and theft of marine resources (Ministry of Defense Regulation Number 13 of 2014). However, this entails substantial costs and is insufficient for comprehensive patrols, as highlighted by the Chief of Indonesian Navy(KSAL) when serving as the Commander of the Joint Defense Area Command I (Pangkogabwilhan I). More specifically, KSAL pointed out that the budget available for Fuel Oil is one of the challenges for patrols in the North Natuna Sea (Ali, 2021).

The global dynamics nowadays are synonymous with technological developments which have led to the concept of digital transformation that needs a more simultaneous and integrated manner and the process of technological innovation in the modern era is a form of enhancing the effectiveness of the national defense system,(Setia & Purwowidagdo, 2015) (Ramadhianto et al., 2023). In line with the aforementioned opinion, the current condition is one that carries the urgency of disruption in the paradigm of national defense in the era of globalization, (Putra Situmorang et al., 2022).Based on this, the researcher will discuss the use of autonomous vehicle systems as an assistance option for patrols in the North Natuna Sea. This is grounded in several factors such as lower operational costs of autonomous vehicles (Bauk et al., 2019), easier maintenance and operation (Klein, 2021), more consistent performance (McCullough et al., 2020), and high monitoring and data analysis capabilities (Mahapatra et al., 2016).

The use of autonomous vehicles can also aid the Command and Control Center (Puskodal) in monitoring and early identification of its main tasks in law enforcement and safeguarding the security of the national jurisdictional maritime areas, specifically the national jurisdictional areas at the border of the North Natuna Sea (LNU) as stipulated in Article 9 of Law Number 34 of 2004 concerning the Indonesian National Defense Forces. In the current situation, Command and Control Centerconducts monitoring and early identification checks with the assistance of the System Performance Readiness and Tactical Analysis (SPARTAN) integrated with the Automatic Identification System (AIS) present on each ship.

There are two indications for taking action against border violators in the waters of North Natuna Sea (LNU). The first is action against violators who activate the Automatic Identification System (AIS), and the second is action against violators who deactivate the AIS. Vessels that activate AIS are fully detected by SPARTAN, and Command and Control Centerthen dispatches the nearest patrol ship for enforcement. However, for vessels that deactivate AIS, the Indonesian Navy (TNI AL) conducts routine patrol operations as described in Article 12, paragraph 1 of Ministerial Regulation Number 11 of 2020 to detect possible violations (Indonesian Navy Staff of Operations, Fleet Command I, 2023).The regulation becomes crucial because regulations are an essential aspect used as a guide for the Indonesian Navy, (Pratama Kamarulah et al., 2023)

Both indications still result in an inefficient enforcement method. The vastness of the LNU waters, limited fleet patrolling, and the uncertainty of patrol ship positions pose challenges, especially when SPARTAN detects activated AIS. Routine patrol operation limitations, including fleet constraints and the vastness of North Natuna Sea waters, exacerbate the issue, compounded by fuel limitations as previously mentioned. Therefore, faced with the efficiency of autonomous vehicles and the various challenges discussed, it is hoped that autonomous vehicles can assist or resolve the issues faced by the Indonesian Navy in fulfilling its primary task of safeguarding maritime border areas, particularly in the LNU waters. Moreover, the relatively lower operational costs and the less significant acquisition costs compared to the expenses incurred by the government in acquiring warships are distinct advantages of autonomous vehicles. One warship's cost is equivalent to that of 10 autonomous vehicles (Octavian, 2023). Given Indonesia's defense budget of less than 1% of the country's Gross Domestic Product (GDP) (Yusgiantoro, 2023), the use of autonomous vehicles becomes a helpful alternative to reduce the costs incurred by the state in safeguarding border areas in the LNU waters.

The most fundamental question is about the urgency of using autonomous vehicles to safeguard the waters of the North Natuna Sea (LNU). It is essential to examine factors related to the strengths, weaknesses, opportunities, and threats for Indonesia in considering autonomous vehicles as one of the options for border surveillance in the LNU.

RESEARCH METHODOLOGY

This research employs a mixed-methods approach, where data collection involves conducting interviews with key informants and administering questionnaires on the strategic factors present in the SWOT matrix. Theoretically, this study utilizes a sequential explanatory design, wherein the interview results are highly relevant for analysis using the SWOT method.

RESULT AND DISCUSSION
Swot Analysis
The SWOT analysis is derived from interview results with various stakeholders. SWOT analysis is a strategic analysis tool used to identify internal and external factors that can influence strategic decision-making. Based on the conducted interviews, the researcher formulates the interview results into various steps, including defining the context, purpose, and objectives, identifying opportunities and threats, defining strengths and weaknesses, and performing calculations to obtain quadrant results in the SWOT analysis to achieve various necessary strategies (Sarsby, 2012).

Context Definition, Purpose, And Objective Of Swot Analysis
Within the aspect of defining the context, as well as the purpose and objectives of SWOT analysis, there are key components that play a crucial role. This is because they aid in formulating appropriate strategies. This includes the reasons why the study is conducted, and the objectives encompass the desired outcomes. Having a clear understanding of the purpose and objectives allows researchers to guide their SWOT analysis in a relevant direction and identify the most critical factors to examine.
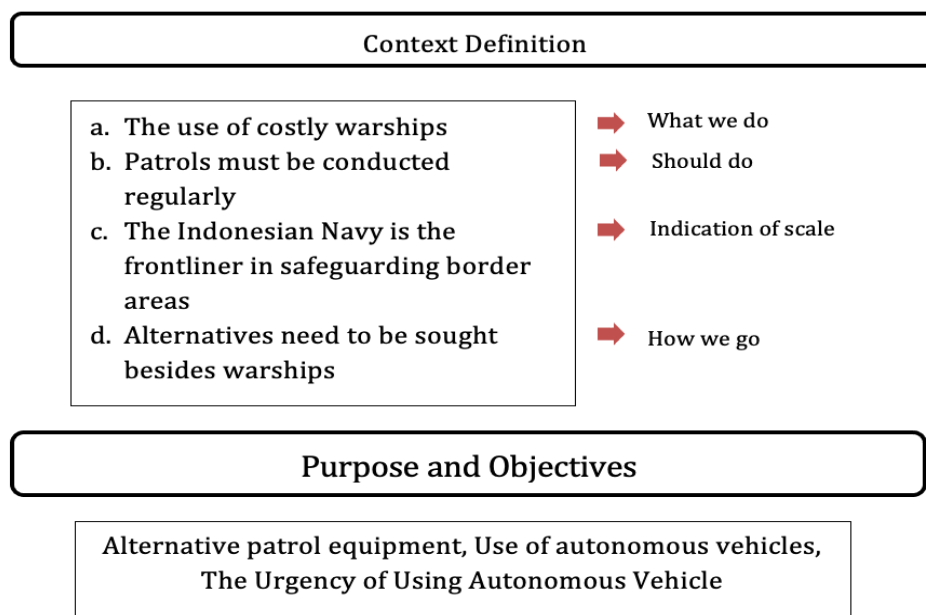

Figure 1. Context Definition, Purpose, and Objectives of SWOT in this Research
Source: processed by researchers, 2023

External Factors Of Swot
After defining the context, purpose, and objectives, the next step is to identify opportunities and threats, (Sarsby, 2012). Opportunities include positive factors that can be leveraged by Indonesia in using autonomous vehicles to safeguard its maritime borders. On the other hand, threats encompass negative factors that may hinder this. In identifying opportunities and threats, the researcher integrates the use of the PESTLE analysis method with the results of the conducted interviews.
The combination of PESTLE and SWOT analysis provides a more comprehensive and in-depth understanding of the external environment, aiding in the formulation of more accurate and effective strategies, (Tirpáková et al., 2023). To elaborate on the external environment in more detail, the researcher categorizes the interview results into three environments: macro-environment, sector environment, and specific environment.

Table 1. The Classification of Interviews into the PESTLE Analysis

NO	Aspect	The Result of Interview
1.	Politics	a. Macro: The use of autonomous vehicles does not violate international regulations. b. Sector: There is currently no use of autonomous vehicles in the border environment of LNU. c. Specific: Indonesia needs to be cautious about embargoes and political dependencies on the country providing autonomous vehicles.

2.	Economy	a. Macro: Autonomous vehicles are sold by various countries, but not their technology. b. Sector: Various countries sell types of autonomous vehicles needed (UAV, UCAV, and AUV). c. Specific: Indonesia, rich in commodities, can be a form of strategic trade cooperation to obtain autonomous vehicles.
3.	Social	a. Macro: Autonomous vehicle technology has been compatible with patrol functions in maritime areas. b. Sector: The use of autonomous vehicles can avoid direct contact between soldiers. c. Specific: Autonomous vehicles do not pose a threat to violators.
4.	Technology	a. Macro: Autonomous vehicle technology has been compatible with the patrol functions in maritime areas. b. Sector: Not all countries are willing to engage in technology transfer c. Specific: Dependence on spare parts and embargoes must be considered.
5.	Environment	a. Macro: The waters of NLU are the focus of China's Nine-Dash Line. b. Sector: Frequent occurrences of fish theft. c. Specific: The presence of the Chinese coast guard following fishing vessels.
6.	Legal	a. Macro: The procurement of defense equipment does not violate regulations, but technology transfer may be difficult as Indonesia is a non-aligned country. b. Sector: There are no prohibitions on the use of autonomous vehicles in border surveillance. c. Specific: International regulations do not prohibit the use of autonomous vehicles.

Source: processed by researchers, 2023

Based on the table above, various environments can be classified into various strategic factors that complement the external environment, consisting of strategic opportunity factors and strategic threat factors. Certainly, these two strategic factors are related to Indonesia's urgency in implementing autonomous vehicles as part of the patrols carried out by the Indonesian Navy in safeguarding the border areas, especially in the North Natuna Sea (LNU) region.
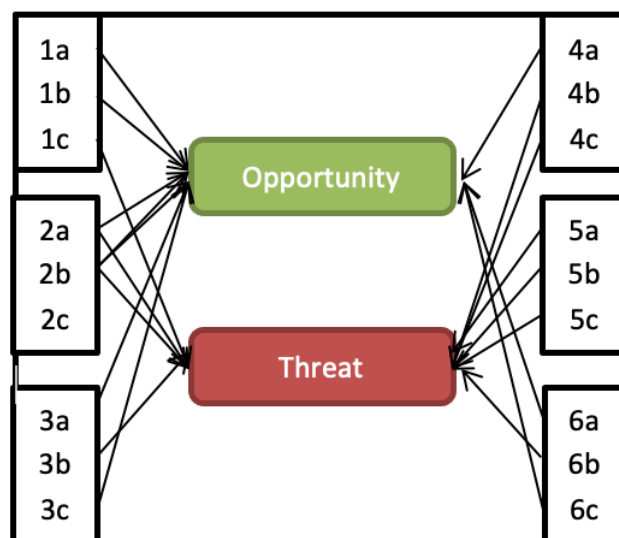

Figure 2. The Classification of the Interviews Point Towards the Opportunity and Threat Factors
Source: processed by researchers, 2023

Based on the classification above, there are 11 aspects that are opportunities and 10 aspects that are threats. Although the total number of classified aspects is 18, there are some aspects that can be categorized as both threats and opportunities, as can be seen in the figure above. Building on the classification above, the researcher simplifies several aspects that share similarities in their environments, resulting in the following simplified strategic factors:

Table 2. The Classified Aspects that that Share Similarities in The Environment: External

NO	External Factor	Strategic Factor
1.	**Opportunity**	a. The use of autonomous vehicles in border patrol does not violate international regulations. b. Autonomous vehicles are freely sold by several countries, including UAVs, UUVs, and UCAVs. c. Autonomous vehicle technology is compatible with the patrol function in the LNU border area. d. Indonesia, rich in commodities, can be used as bargaining power for strategic trade-offs to obtain technology transfer.
2.	**Threat**	a. Not all countries are willing to transfer technology, and the industry's readiness for research and development is insufficient. b. The LNU area is the focus of China in the Nine Dash Line, which could trigger political conflicts. c. The possibility of an embargo on autonomous vehicle spare parts should be a serious concern. d. The involvement of the Chinese coast guard in escorting poaching vessels may resist the use of autonomous vehicles in border patrol.

Source: processed by researchers, 2023

Internal Factor Of Swot

In determining the internal factors of SWOT, the researcher adopts an interpretative approach by integrating theories, regulations, and interview results. This process yields the strategic factors of strengths and weaknesses as follows:

Table 3. The Classified Aspects that that Share Similarities in The Environment: Internal

No	Internal Factor	Strategic Factor
1.	**Strength**	a. The use of autonomous vehicles is more cost-effective compared to warships. b. The use of autonomous vehicles realizes more efficient patrols. c. The use of autonomous vehicles can be simultaneously integrated into the Command and Control Center (Puskodal). d. The use of autonomous vehicles is a good alternative to address the shortage of fuel in warships.
2.	**Weakness**	a. Besides requiring a large budget for technology transfer, the domestic industry also has minimal capabilities. b. Training for soldiers is required, which will take a considerable amount of time before autonomous vehicles can operate promptly. c. Understanding from all stakeholders is needed to incorporate autonomous vehicles into the strategic development plan of the Indonesian Navy. d. Indonesia, being a non-aligned country, can complicate negotiations regarding the autonomous vehicle technology transfer process.

Based on the results obtained from the questionnaire given to the respondents, the following outcomes were identified:

Table 4. The Value of Strategic Factor

	Strategic Factor	Value
Strength	Cost-Efficient	7,363
	More-Efficient	7,757
	Easily Integrated	7,484
	No Fuel Dependency	7,666

Weakness	High Cost for Technology Transfer	6,151
	Time for Soldier Training	6,393
	Stakeholder Understanding	6,363
	Negotiation of ToT	6,666
Opportunity	Compliance with International Regulations	7,424
	Freely Sold by Various Countries	7,090
	Technology Compatibility with Patrol Functions	7,454
	Commodity Trade as a Bargaining Power	7,303
Threat	Insufficient Industry in Indonesia	6,424
	Political Conflict in LNU Borders	7,242
	Embargo	6,606
	Resistance of China's Coast Guard	7,242

Source: processed by researchers, 2023

Based on the obtained results, IFEM (Internal Factor Evaluation Matrix) and EFEM (External Factor Evaluation Matrix) matrices can be formed by considering the weight and rating values to calculate the total for each strategic factor. For the weight values, they are calculated using the following mechanism:

Table 5. The Classification of Value Provided by Respondents

Significant Value	1	1,5	2	2,5	3
The range of weights provided by the respondents	nb>6,5 nb<7	nb>7 nb<7,5	nb>7,5 nb<8	nb>8 nb<8,5	nb>8,5 nb<9

Source: processed by researchers, 2023

The table above represents the significant value range determined based on the respondents' weight range. Subsequently, a simple calculation is performed using the following formula:

$$B = \left(\frac{nb\,(1-n)}{\Sigma n=1\ nb\ (1-n)}\right) : \Sigma_{n=1} \left(\frac{nb\ (1-n)}{\Sigma n=1\ nb\ (1-n)}\right)$$

Where:
B   =Weight according to the assessment criteria of IFEM and EFEM matrices
BS   = Significant Value
nb   = Weights provided by the respondents

The calculation for the rating is done through the assessment of ratings by the respondents. Based on these two assessment mechanisms, the combined results of the IFEM and EFEM matrices are as follows:

Table 6. The Matricof SWOT (IFEM and EFEM)

	Strategic Factors	Significant Value	Respondent Value	Weight	Rating	Total
S	Cost-Efficient	1,5	7,363	0,1304	4	0,19

	More-Efficient	2	7,757	0,1739	5	0,34
	Easily Integrated	1,5	7,484	0,1304	4	0,19
	No Fuel Dependency	2	7,666	0,1739	4	0,34
Weakness	High Cost for Technology Transfer	1	6,151	0,0869	2	0,08
	Time for Soldier Training	1	6,393	0,0869	1	0,08
	Stakeholder Understanding	1	6,363	0,0869	2	0,08
	Negotiation of ToT	1,5	6,666	0,1304	1	0,13
Total of IFEM Matric						**1,54**
Opportunity	Compliance with International Regulations	1,5	7,424	0,1428	4	0,57
	Freely Sold by Various Countries	1	7,090	0,0952	3	0,28
	Technology Compatibility with Patrol Functions	1,5	7,454	0,1428	3	0,42
	Commodity Trade as a Bargaining Power	1,5	7,303	0,1428	1	0,42
Threat	Insufficient Industry in Indonesia	1	6,424	0,0952	1	0,09
	Political Conflict in LNU Borders	1,5	7,242	0,1428	2	0,28
	Embargo	1	6,606	0,0952	3	0,28
	Resistance of China's Coast Guard	1,5	7,242	0,1428	2	0,28
Total of EFEM Matric						**2,66**

Source: processed by researchers, 2023

Based on the calculation table above, the quadrant of the total calculation will then be determined to indicate the urgency of using autonomous vehicles in safeguarding the maritime border areas in the North Natuna Sea. Certainly, this SWOT quadrant will provide a clearer picture of the strategic position of using autonomous vehicles in the context of maritime security in that area. By understanding this quadrant, strategic steps can be formulated to utilize the potential of autonomous vehicles more effectively in addressing challenges and optimizing opportunities in maintaining sovereignty and maritime security in the North Natuna Sea region. The results of the quadrant can be seen in the figure below:
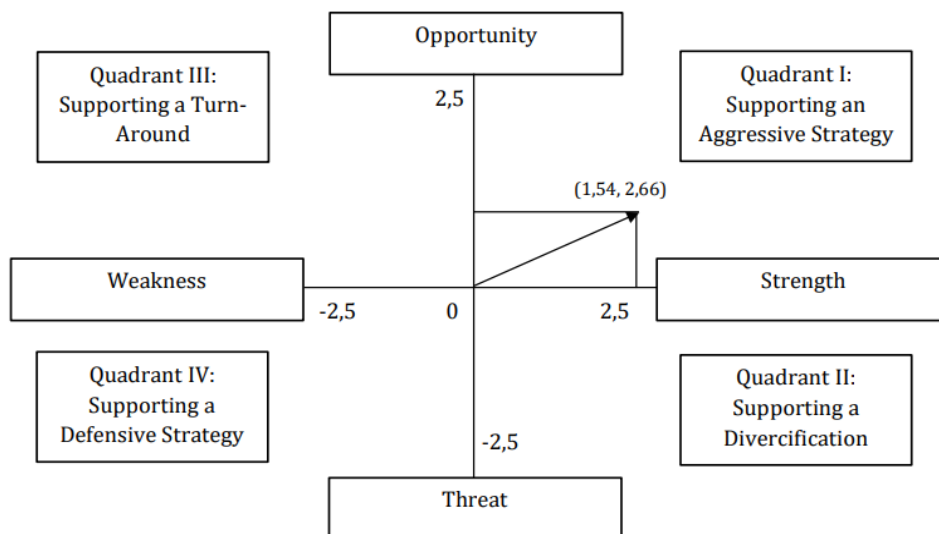

Figure 3. The Quadrant of Autonomous Vehicle for Securing Bordering Nations
Source: processed by researchers, 2023

Based on the results of the quadrant, it can be observed that the autonomous vehicle patrol system in the border region falls into an aggressive strategy. This means that the strategy is above average, in this case, it is at a level that needs to be implemented based on considerations of the opportunities and threats that the country currently faces related to issues in patrolling the LNU region, as well as the strengths and weaknesses of autonomous vehicles. The elaboration of the SWOT strategy as the embodiment of using autonomous vehicles to safeguard the border areas includes the following:

a.   **SO (Strenght + Opportunity)**
     Every strategic strength of autonomous vehicles is a manifestation of every weakness in the existing patrol system, including high operational costs and a lack of fuel. On the other hand, existing opportunities further strengthen the position of autonomous vehicles to be utilized as patrol tools, given their advanced technology, availability in the market, compliance with international regulations, and the potential for acquisition through trade mechanisms.

b.   **WO (Weakness + Opportunity)**
     The weaknesses of autonomous vehicles, such as technology transfer, stakeholder understanding, and training time, can be addressed over time.

c.   **ST (Strength + Threat)**
     The threats posed to autonomous vehicles, including industry readiness, embargoes, and resulting resistance, can be addressed through negotiations, providing understanding, and developing defense industries.

d.   **WT (Weakness + Threat)**
     The weaknesses and threats of autonomous vehicles do not significantly impact the sovereignty, integrity, and safety of the nation compared to their goal of securing border areas.

Based on the classification of strategies outlined above, and based on the quadrant results obtained, there are 3 top strategies with the highest scores in determining the urgency basis of using autonomous vehicles in safeguarding the border areas in the North Natuna Sea (LNU) as follows:

a.   **S2 – O3: 0.34 x 0.42 = 0.1428:** The results of this urgency basis indicate that integrating the strengths of more efficient autonomous vehicles with the opportunities provided by the technology they possess can significantly enhance effectiveness in securing maritime border areas. In this context, the use of technology compatible with the needs of maritime border security can optimize the performance of autonomous vehicles in detecting, monitoring, and responding to potential threats in real-time. Thus, a well-integrated combination of autonomous vehicle technology capabilities and specific maritime border security needs can result in a more comprehensive and responsive system for safeguarding border area security.

b.   **S4 – O4: 0.34 x 0.42 = 0.1428:** The results of this urgency basis indicate that combining the strengths of autonomous vehicles that do not rely on the use of oil-based fuels with the opportunities provided by the government through trade-offs to acquire autonomous vehicles is a promising strategy in addressing the challenge of the difficulty in obtaining oil-based fuels for patrols in the North Natuna Sea border area.

c.   **S1 – O1: 0.19 x 0.57 = 0.1083:** The results of this urgency basis indicate that combining the strengths of autonomous vehicles with high cost efficiency with the opportunities provided by autonomous vehicles that do not violate regulations in their use to maintain maritime border area security is a highly potential strategy in enhancing the effectiveness of security operations in those waters.

Based on the top three classifications of strategies in the urgency of using autonomous vehicles to safeguard the border areas in the North Natuna Sea, it is indicated that this strategy can provide an answer to the issue raised by the Staff of Operations, Fleet Command I regarding the difficulty of fuel supply in maintaining border areas. The findings of this research also support the opinion of the Deputy Head of the National Research and Innovation Agency that the cost required to acquire autonomous vehicles is 20 times lower compared to the cost incurred in acquiring warships, even though the reliability and efficiency level of autonomous vehicles are significantly better in terms of patrol activities.

CONCLUSIONS, RECOMMENDATIONS, AND LIMITATIONS

Based on the obtained results, it can be concluded that the urgency of using autonomous vehicles to safeguard the maritime borders in the North Natuna Sea is crucial. The three underlying foundations of the quadrant calculation outlined in the discussion indicate that each strategic strength of autonomous vehicles reflects weaknesses in the current patrol system. Based on the analysis of the combination of strategies, it indicates that this strategy can be a solution to the problem of the insufficient intensity of patrols due to logistical shortages (fuel). The advantages of autonomous vehicles, which do not incur expensive operational costs and do not use fossil fuels, make them an alternative that can maximize

opportunities for the Indonesian Navy to modernize its equipment as a manifestation of technological advancements in the defense sector. Therefore, faced with the potential losses for Indonesia if the current patrol mechanism is maintained, the use of autonomous vehicles becomes urgent when confronted with the potential they possess in safeguarding the border areas of the North Natuna Sea. This supports the research findings of Hadi Pranoto and Amarulla Octavian, stating that the strategy for securing the Sea Lanes of Indonesia involves employing a border pattern with the support of the readiness and capabilities of the Republic of Indonesia's ships. These capabilities are limited and require improvement in ship monitoring through the utilization of technological advancements, (Pranoto & Octavian, 2015). For future works, a more in-depth exploration is required regarding the characteristics necessary forautonomous vehicles in safeguarding border areas, especially in the northern Natuna Sea. This is because this research is limited to determining the general urgency of using autonomous vehicles without considering the specific characteristics required for autonomous vehicles in patrolling maritime border areas.

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